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Power Generation

and POWER PLANT ENGINEERING

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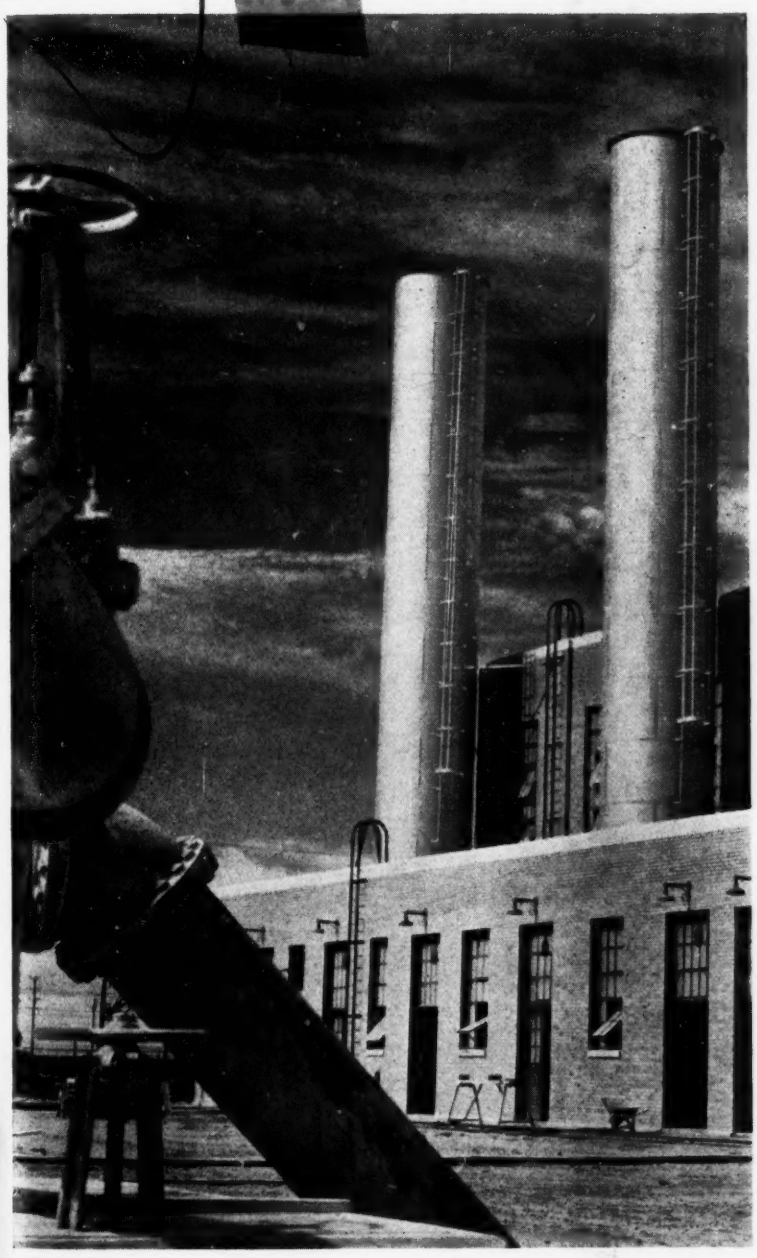

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COVER: General exterior new power plant of Southwestern Public Service Co., at Amarillo, Texas. (By Ewing Galloway)

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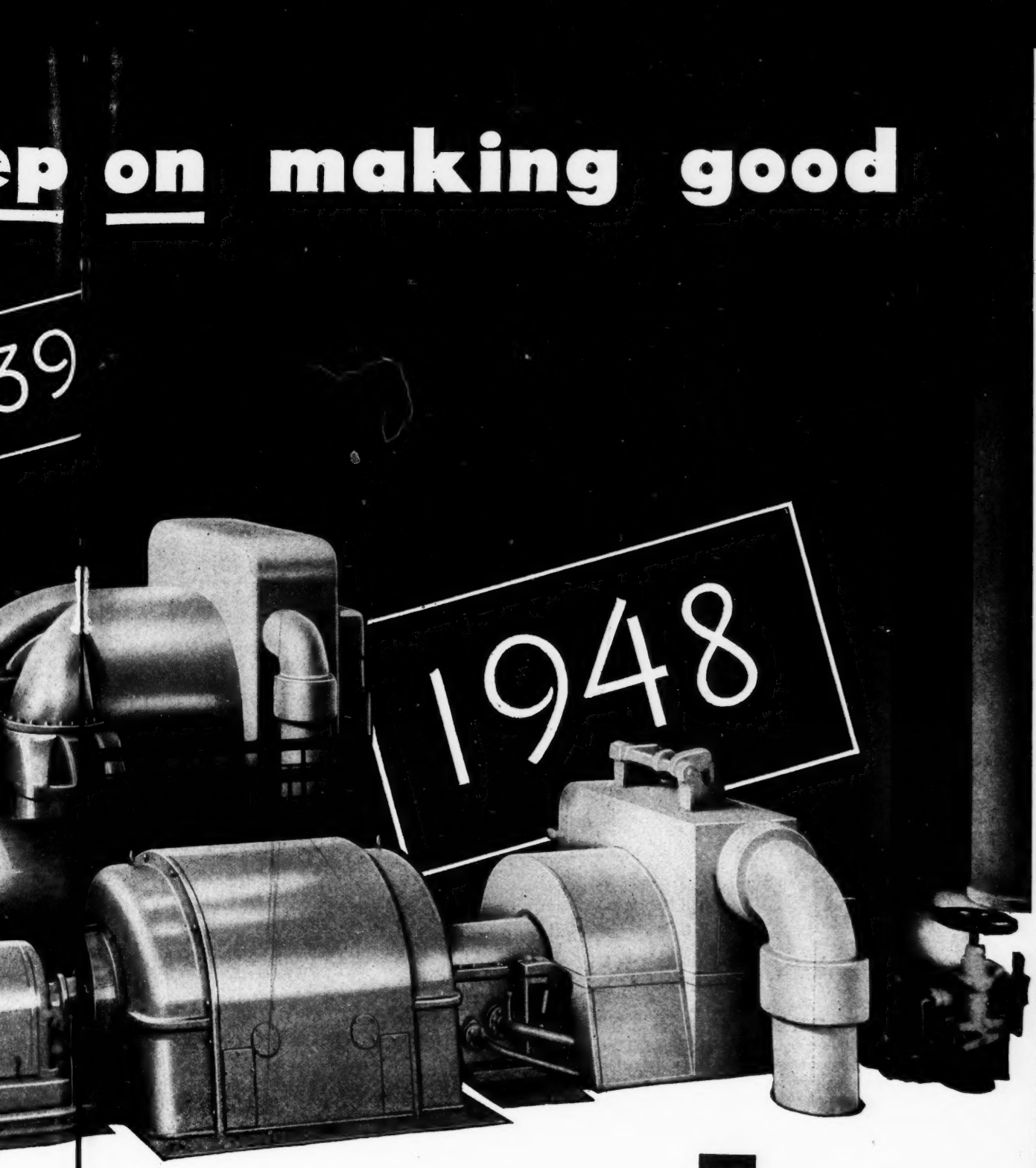

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Power Generation

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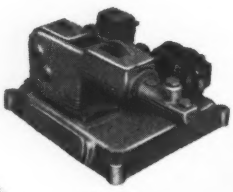

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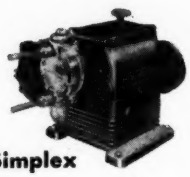
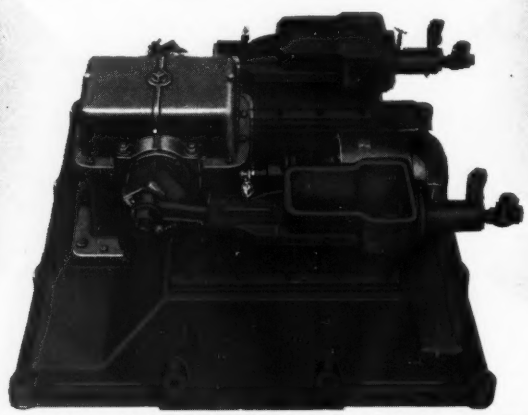


Simplex

Also available in Triplex and Quadruplex designs

Also available in Triplex and Quadruplex designs

TO THE LARGEST HIGH PRESSURE INSTALLATION



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ENGINEERS' PREVIEW

APPLICATION of electronics and electronic techniques to the solution of important industrial problems has been singled out by the National Security Resources Board, acting under the National Security Act of 1947, as one of 14 key industrial applications vital to the present-day U. S. production efforts. Leaders in both education and industry attach great significance, therefore, to the opening in New York City of the first trade school licensed by the State of New York for the training of technicians in this specialized field. This is the School of Industrial Technology, Inc., where complete courses are now being given.

The course in Industrial Electronics comprises 1000 hours of instruction, available to students in separate morning, afternoon, and evening sessions, with new classes scheduled to begin every four weeks. Class and laboratory work includes (1) a 250-hour grounding in general technology and industrial practice; (2) a rigorous treatment of electricity and electronics (450 hours); and (3) 300 hours of practical work covering the trouble shooting, maintenance, and repair of high frequency heaters, motor controls, welding controls, and industrial process controls for timing, sorting, counting, inspection, temperature, liquid level, and other industrial electronic applications.

Director of the School of Industrial Technology is Theodore C. Gams, consultant in the field of industrial electronics, and instrumental in developing the first coordinated college program for training industrial electronic engineers at the Polytechnic Institute of Brooklyn.

★ ★ ★

PROCESS which will lock an effective mildew-preventing chemicals into linens has been announced by Monsanto Chemical Co. The new process, a modification of an old method for fire-proofing textiles, will treat 300 lb of laundry for a few cents. It was developed in cooperation with Morgan Linen Service Co. and can easily be meshed with normal commercial laundry washing procedures. Basis of the treatment is a concentrated solution of sodium pentachlorophenate, a water-soluble fungicide.

★ ★ ★

"WE HOPE you always have a quick and reasonable answer ready when the customer asks an unusual question," says Al Wynkoop in the *Survey*, U. S. Machine Co. house organ, (passed on by *Coal Heat* and now by us). "Like this incident, for example: One day P. R. Deane, Winkler distributor at Geneseo, Ill., was demonstrating a domestic stoker to a woman who displayed considerable interest as he pointed out the various exclusive features of the stoker.

"As P. R. came in from the oratorical clouds for what he hoped would be a perfect landing, she said: 'Mr. Deane, there's just one thing more. Would you please show me the depreciation? My husband always says when you buy a piece of machinery you should think about the depreciation. I don't believe you showed me that.'

"Never batting an eye, P. R. replied: 'Madam, I'm glad you brought that up. You see, depreciation seemed to be such a source of annoyance we had it removed altogether.' (Don't kid yourselves, classmates—he made the sale!)" But if you can't remove it, see page 109.

COMMUNICATION between workers in noisy places like steel mills, ship's engine rooms, boiler factories etc., will be much easier due to a new invention of Albert E. Woodruff, of Oak Park, Ill. and William M. Blair of Washington, D. C. This is in the form of a microphone that clamps to the nose of the speaker in the manner of a pair of glasses. Operating on the principle of bone conduction, it picks up the speaker's voice but eliminates the air-gap, thus shutting out external noises. When ordinary microphones are used in noisy places, the outside noise and speaker's voice are both picked up and amplified.

★ ★ ★

RAPID MEASUREMENT and recording of heat exchange between the human body and its environment is being studied by the Research Laboratory of the American Society of Heating and Ventilating Engineers. This study is being sponsored by the Naval Medical Research Institute and the Office of Naval Research. The initial investigation is concerned with the possibility of designing, developing and constructing a calorimeter capable of holding a human subject. In addition to measuring the heat exchange of the body with its surroundings, the calorimeter must be capable of creating sudden changes in environment. Thus observations of the heat exchange of the human body under a variety of experimental conditions can be made. Previous research has established the mechanics by which the temperature control system of the body maintains approximately constant internal temperatures over a wide range of environmental conditions. However, little is known about the effect of environment on the heat generated within the body. It is hoped that these studies will add materially to our understanding of the effect of environment on human metabolism.

★ ★ ★

KNOWN as RD-119, newly-discovered rust-preventing fluid is now being added to all Sinclair petroleum products as they flow through pipelines to distribution points. Under this new process, all the oil company's products, such as gasoline, kerosene, heating oil and Diesel oil will contain an effective portion of the rust inhibitor.

★ ★ ★

INCREASE IN CUTS and infections caused by improper disposal of old and used fluorescent tubes and mercury vapor lamps has prompted the publication of another safety booklet by the Accident Prevention Department of the Association of Casualty and Surety Companies. Titled "Your Guide to Safety When Disposing of Fluorescent and Mercury Vapor Lamps," the pocket-size booklet points out inherent dangers in the tubes and directs their safe disposal. Aside from the hazard of breaking glass, the safety guide says, persons disposing of the lamps may be endangered by inhaling even small quantities of the toxic materials inside the tubes. In addition, if the phosphor powder clinging to the pieces of broken glass should get under the skin, it prevents healing of the wound. Copies of the new safety booklet are available through member companies of the Association.

GENERAL LUCIUS D. CLAY, commander-in-chief of American Forces in Europe and military governor of the U. S. Zone in Germany, is among five eminent engineers who have been elected to Honorary Membership, its highest award, by the American Society of Civil Engineers. Others who will receive the awards, at the Society's annual meeting on January 19, are: Charles H. Buford, Chicago, President of the Chicago, Milwaukee, St. Paul and Pacific Railroad, an authority in the field of railroad operation and railroad engineering economics; Professor Donald Derickson, New Orleans, retired head of Tulane University's Civil Engineering School, author of college texts and prominent in the field of engineering education; Gano Dunn, President of the J. G. White Engineering Corporation, New York, widely known engineer and industrialist and recipient of various honors, including the Edison Medal, the Hoover Medal and the Egleston Medal of Columbia University; Andrew Weiss, Mexico City, consulting engineer for the Mexican National Commission of Irrigation, prominent in the development of reclamation engineering in Mexico.

★ ★ ★

THE ENGINEER of the future, constructing elaborate mechanical and electrical "gizmos," will be relieved of hours of laborious and, frequently, impossible computations by using a new instrument designed and built at Northwestern University. The device, whose formidable technical name is "resistance-capicitance analogue computer," was developed under the direction of Associate Professor Richard W. Jones by graduate students Herbert W. Schultz and David C. McKlintock of the department of electrical engineering in the University's Technological Institute. According to Prof. Jones, "the computer will be of great value to engineers designing control systems, as well as serving as an educational tool in the classroom." Among the computers already in existence, this new apparatus has the advantage of simplicity of operation, as well as sufficient accuracy for most engineering purposes. Prof. Jones is especially interested in the applications to which the computer may be put in helping the student to understand the principles of transient vibrations encountered in engineering.

He is equally enthusiastic over the possibilities of greater use in the future of the analogue concept as a tool of analysis. For example, alongside the analogue computer in the electronics laboratory at Northwestern is another analogue device termed the "simulator." This instrument is being used to determine certain characteristics of an automatic pilot control system similar to those used in aircraft.

"Since it is not feasible to bring the actual airplane into the laboratory," said Prof. Jones, "we have constructed an electrical analogue which will generate to the autopilot the same characteristics found in the actual aircraft in flight. In this way, the altitude of the flying airplane is simulated electrically, and the responses set up in the autopilot studied."

This is but one of many applications of the analogue computer, or modifications of it, and Prof. Jones predicts an increasing use of the device in the solution of varied problems in engineering.

★ ★ ★

UNUSUAL METHOD of making iron nuts is in use in a European plant. Powdered iron is compacted around a threaded insert which, when unscrewed, forms threads. The nut is then sintered in accordance with common practice.—*The Ohmite News*

MICRO-FILM CAMERA capable of photographing unusually large copy up to 42 in. in width, by any length, in one continuous exposure was announced recently. The camera, which also serves as a film printer and enlarger, is called Flofilm and is the result of years of experiment by Diebold Laboratories to broaden the application of the automatic flow principal of microphotography to include records and documents wider than the present limitation of 14 in. Its principal applications are in the microreproduction of engineering drawings, newspapers, blueprints, maps, surveys, and large production control and accounting records. The camera resembles a home laundry mangle and is fed much the same as a blueprint printer.

★ ★ ★

AS A RESULT of continued research and experiments with war-time equipment, it is now possible to produce seamless tubes and pipes in sizes more than double those avaliable before the war, says The International Nickel Co., Inc. A 4000-ton extrusion press, installed at Inco's Huntington Works during the war and used largely for the production of rotating shell bands, is now producing pipe in nickel, Monel and other high nickel alloys in diameters up to 9¼ in. and in lengths up to 12 ft. These shapes can be further cold drawn into seamless pipe 8 in. in diameter, wall thicknesses up to ¾ in., and in varying lengths. Prior to the war, the largest size available in pipe and tubing of nickel and the high nickel alloys was 5 in. in diameter. While large piping and tubing in the Inco nickel alloys have been available in centrifugally cast or welded form, this is the first time they have been made in these sizes by forging, extruding, and cold drawing into seamless form.

★ ★ ★

SELECTION of the annual winner of the Charles A. Coffin Medal, established by the General Electric Co. and emblematic of high achievement in the electric light and power industry, will take place hereafter under a new procedure recently approved by the Charles A. Coffin Foundation, donor of the Award, and the Board of Directors of the Edison Electric Institute. Under the new procedure, five companies, to be chosen through a nominating and reviewing process now being established, will be invited by the President of the Institute to compete for the Award. From these companies the Award Committee will establish the winning company, after careful evaluation of the data relating to the accomplishments of the companies under consideration. Formerly a general invitation to compete for the Award was given to all operating companies.

★ ★ ★

TWO KODAK RESEARCHERS, George C. Higgins, and Keith Stultz, have found that the visibility of parallel lines in a test object used in their experiments is 10 to 20 per cent lower when the lines are viewed at an angle of 45 degrees to the horizontal. The lines are that much harder to see when turned at that angle. Turn a newspaper picture halfway to the right or left so that the lines of dots are either vertical or horizontal. The result, if you have the picture at average reading distance and if it is of moderate density, is that you will see the lines stand out in the picture. So you see, the phrase "to have the right slant on things" is no mere figure of speech.

I'M A TWO-HANDED CATCHER!

"I am De Laval Centrifugal Force, and when I go to work to remove impurities from lubricating oil, I get rid of ***both*** contaminants — ***dirt*** and ***water***. My centrifugal force throws out every drop of water, which is continuously discharged to waste. Simultaneously I throw out any ***solid*** impurities which are collected in the dirt holding space of the bowl of the centrifuge but out of the way of the oil being purified.

"It makes no difference whether I am asked to purify turbine oil or Diesel oil. Whenever I am on the job, the power plant engineer can be confident that his power plant is protected from trouble at all times.

"I am also tops at dehydrating and cleaning Diesel fuel oil. When used for this purpose I enable the operator to get the maximum BTU value from every gallon of fuel oil."

● ***Bulletin TO 1-12 gives you further details. Write for it.***

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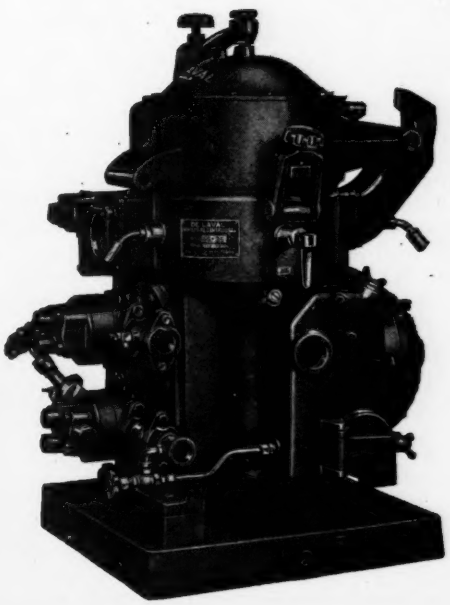
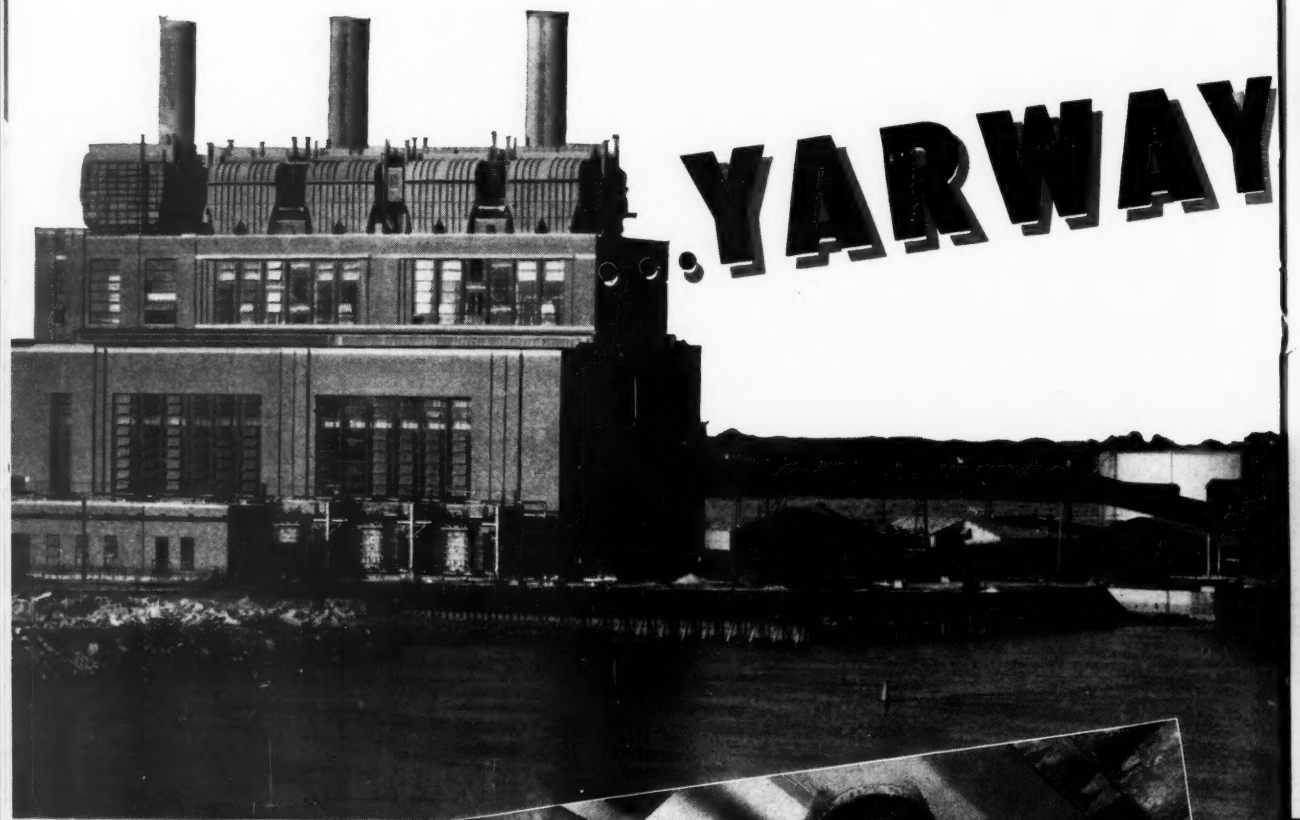


DE LAVAL
Lubricating Oil Purifiers

Public Service (N.J.) *Chooses* YARWAY



Burlington, N. J., Station of the Public Service Electric and Gas Company. Four boilers at this plant, and two at Public Service's Marion Station are each equipped with two Yarway Unit Tandems. Steam pressure boiler 1350 psi, turbine 1250 psi. Temperature 950° F. Output, each boiler, 350,000 lbs per hour; high pressure turbines, 125,000 KW each.

YARWAY BLOW-OFF VALVES

UNIT TANDEMS

FOR HIGH PRESSURE BLOW-DOWN SERVICE

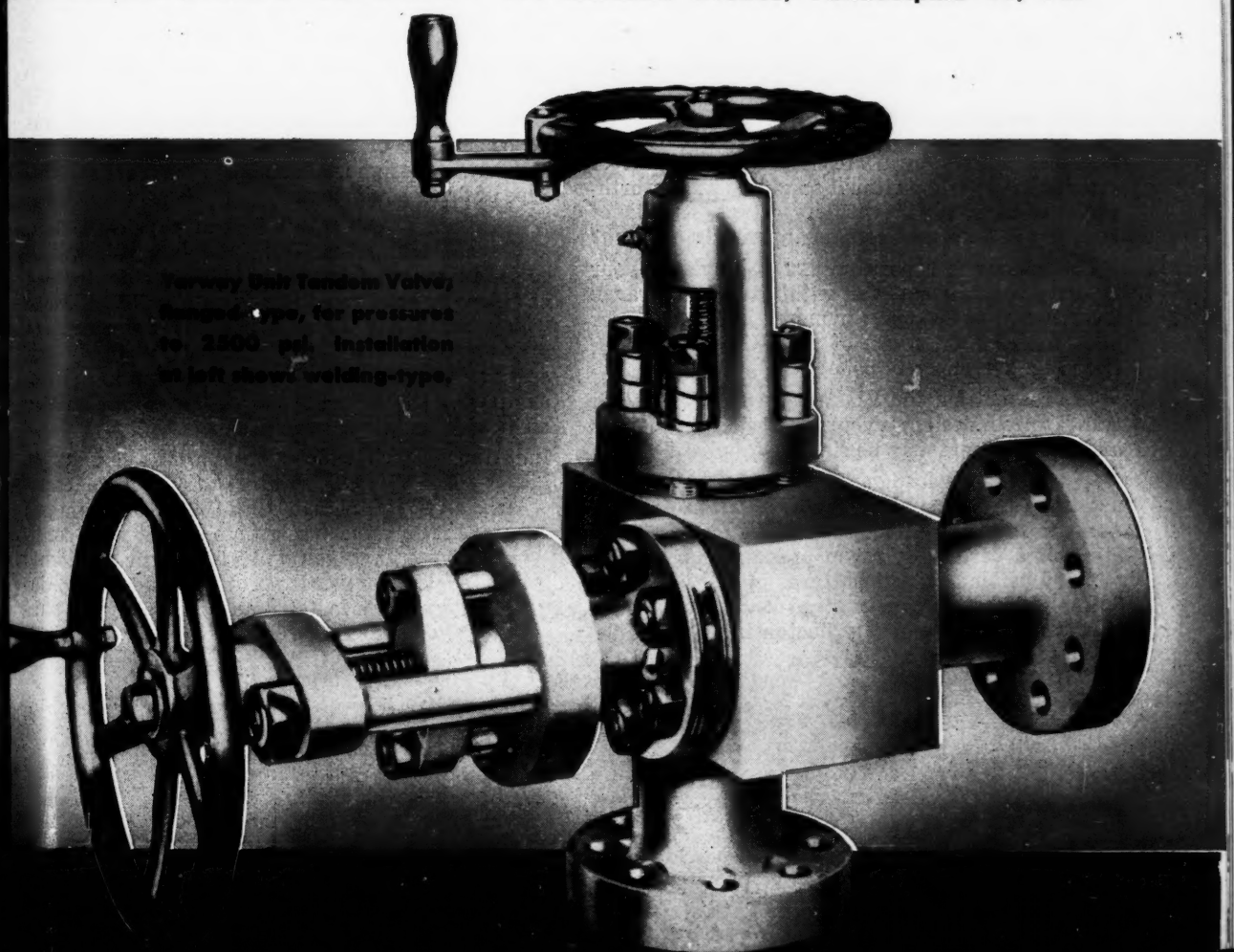
Why has the Public Service Electric and Gas Company of New Jersey, like so many other leading utilities, selected Yarway Unit Tandem Blow-Off Valves for their high pressure boilers? The answer is simple—*proved performance.*

Yarway Unit Tandems have proved themselves unequalled in service throughout all industries on pressures from 400 to 2500 psi. This tandem is a combination of the Yarway Hard-Seat* Valve (next to boiler for blowing) and the famous Yarway Seatless Valve (for sealing)—both contained in a one-piece forged steel body. This rugged construction eliminates the interconnecting flanges, bolts and gaskets required in bolted tandem designs, making a trim, compact unit.

Nearly 40 years of laboratory and field experience concentrated on blow-off valve requirements, makes Yarway a logical source of supply for your next blow-off valves. Write for Catalog B-432 for pressures up to 2500 psi . . . Catalog B-424 for lower pressures.

*Seats furnished either separate or integral.

YARNALL-WARING COMPANY • 114 Mermaid Avenue, Philadelphia 18, Pa.



Yarway Unit Tandem Valve; flanged type, for pressures to 2500 psi. Installation in left shows welding-type.

Is a Standardized Boiler Unit THE BEST ANSWER for your steam needs?

Sure – your plant is different. Your combination of load, pressure and temperature requirements, fuel situation and physical layout – when put together – probably poses a problem different from that of any other plant in the country. *But* – can all these variables be met by a steam generating unit of standardized design without sacrifice of any worthwhile advantage and with important benefits of economy in both first cost and operating expense?

The answer is a positive YES – providing your capacity requirements fall within the broad range from 15,000 to 300,000 (or more) lb of steam per hr – the capacity range of the VU family (illustrated on the opposite page).

The reason that the VU family can meet – with standardized design – your particular conditions and requirements may be simply stated.

FIRST – let's take load, pressure and temperature conditions. VU Units are in service – many for more than 10 years – operating at a variety of steam pressures up to 1,000 psi and at temperatures to 900 F and above. They are meeting load conditions that vary from the widely fluctuating demands of certain process industries to the above-capacity requirements of overloaded steam plants.

NEXT – let's consider your fuel situation. The VU family is versatile. No matter what fuel – oil, gas or coal, alone or in various combinations – the VU furnace design is adaptable to the most suitable type of firing equipment.

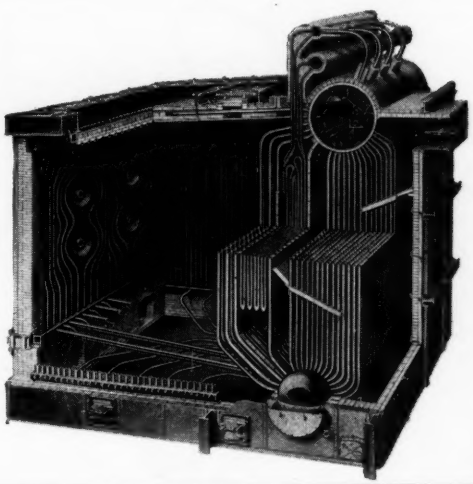
AND FINALLY – let's take a look at physical layout, i.e., space conditions. With the integral, water-cooled furnace in front of the boiler surface instead of below it, head room is seldom a problem. Since width, depth and distance between drum centers are variable in standard increments, virtually any space situation can be met. And you can have deep ash pits or shallow as required, economizer and/or air heater surface if necessary.

Industry – world-wide – has purchased units of the VU family with an aggregate capacity of more than 88,000,000 lb of steam per hr. So you can select a VU Unit with confidence that you will get all the economic benefits of service-proved, standardized design in an installation suited to your particular conditions. B-265

C·E

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

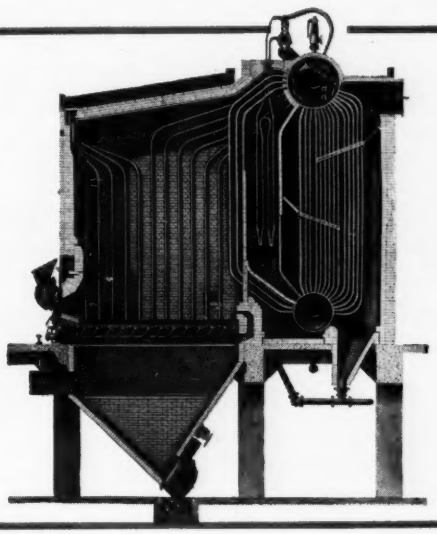


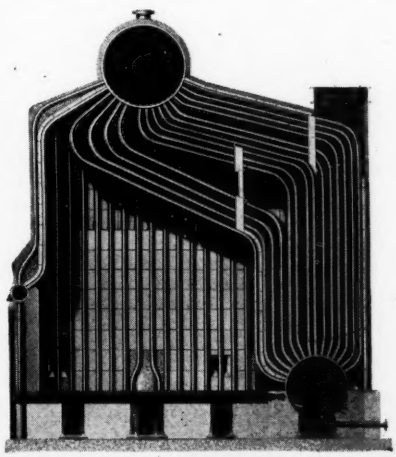
Type VU Steam Generator (for the higher capacity range)

This unit, the original VU design, may be fired by pulverized coal, oil or gas, or any combination of these fuels. Available for capacities up to 300,000, or more, lb of steam per hr, pressures up to 1000 psi and steam temperatures up to 900 F, or higher. Furnace bottom may be as shown or may be of hopper type. Economizer or air heater surface may be added.

Type VU Steam Generator (for the middle capacity range)

In this VU design, shown equipped with a C-E Spreader Stoker, the furnace proportions and arrangement of water wall surfaces may be adapted for firing by any type of mechanical stoker. Design is also adaptable for firing by oil or gas. Economizer or air heater surface may be added. Approximate capacity range 25,000 to 100,000, or more, lb per hr.





C-E Package Boiler (for the lower capacity range)

This member of the VU family is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 15,000 to 50,000 lb per hr. Firing may be by spreader stoker, single-retort underfeed stoker, oil or gas burners. Any of these methods may be substituted for any other, should fuel market conditions make this desirable.

C-E ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

Bomb

b attack on boiler problems

Any thorough study of boiler water problems involves investigations under conditions which simulate those of actual boiler operations. That is the reason for "bombs"—strong, thick walled cylinders of various sizes and types in which water or solutions of various kinds can be subjected to the highest temperatures and pressures encountered in modern boilers.

These "bombs" are a standard tool at Hall Laboratories. Sometimes they are used in studying the solubility of a substance, sometimes to investigate decomposition of different solutions at those high pressures and temperatures, sometimes to determine the effect on the bomb metal —which is the same as the metal of the boiler— of various substances that are found in or added to boiler water.

Through this and other methods of inquiry, Hall Laboratories learns not merely what reaction takes place in a test tube but *what will happen in your boiler.*

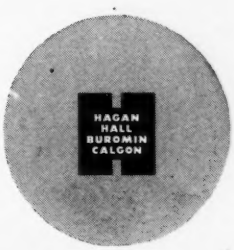
"Bomb" studies are typical of the thoroughness with which Hall Laboratories investigates every aspect of boiler water conditioning. The original Hall system of boiler water conditioning was based on thorough research, and thorough research maintains Hall leadership — which is one more reason why so many plants of all sizes, in all industries, in all parts of the country, use Hall service.

Hall Laboratories, Hagan Building, Pittsburgh 30, Pennsylvania.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL



Can you hang this sign on your turbines?

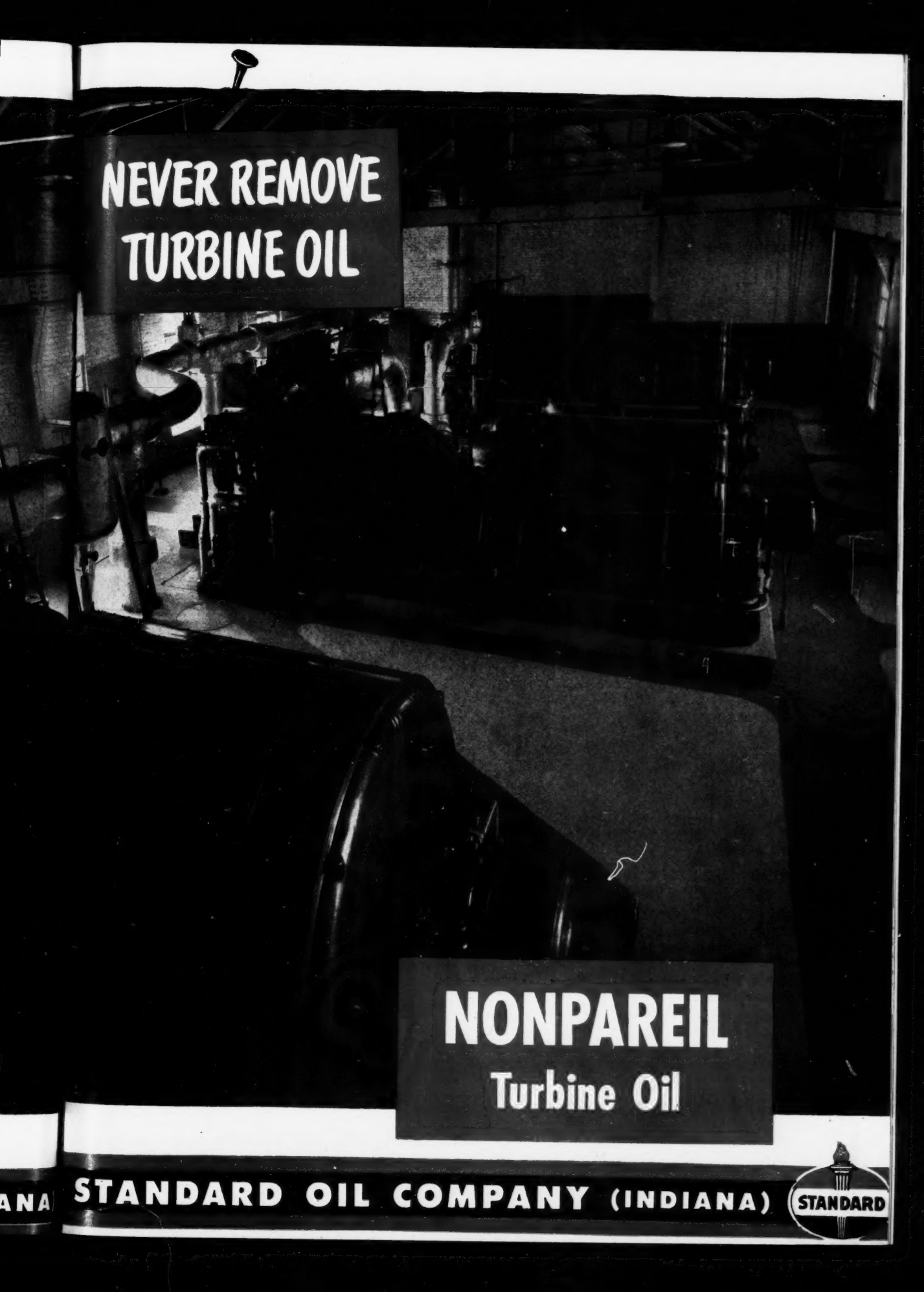
Could the oil in your turbines today be left there for the next 10 or 15 or 20 years without removal for treating, resting, or cleaning the oil system? Yes, if it were Nonpareil Turbine Oil. For instance, take Nonpareil's operating record in the midwest utility plant shown at right.

Nonpareil was put into three 5,000 KW General Electric turbines in July 1932, November 1934, and November 1940, respectively. The first fills of Nonpareil have never been removed from the three turbines. In 16 years' operation in one unit, Nonpareil maintained an average neutralization number of .06 mg. KOH/gm. Because of low-acidity operation, there has been no need for treating oil or cleaning turbine oil systems.

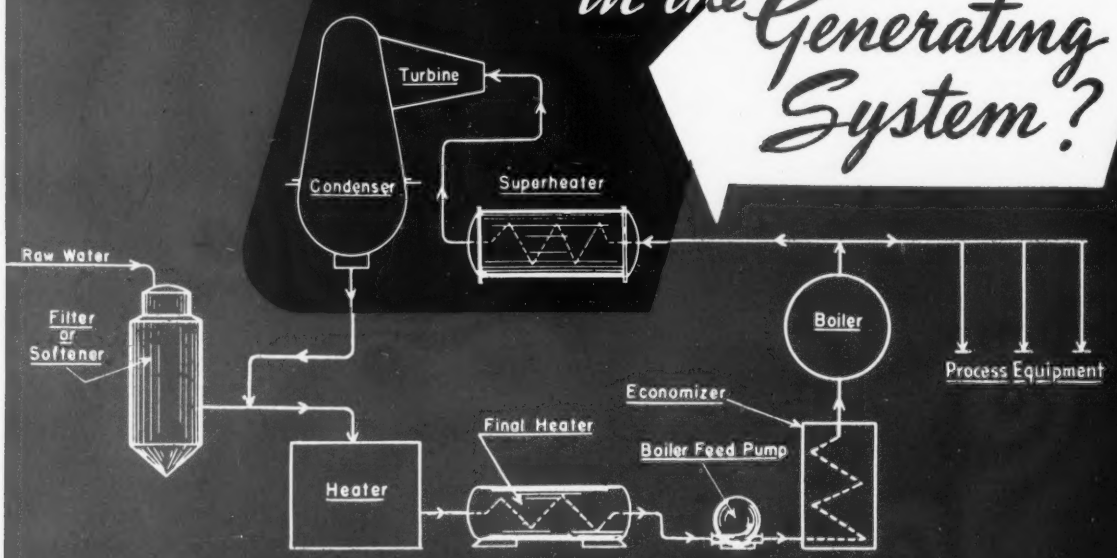
Why risk dangerous acidity increase that can lead to the formation of harmful deposits and emulsions in turbine oil? Make your next fill Nonpareil Turbine Oil. It contains anti-corrosion and anti-foaming agents further to assure safe operation for the "life of your turbine."

Ask a Standard Oil Lubrication Engineer about the benefits of the written guarantee you receive with Nonpareil. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)


NEVER REMOVE
TURBINE OIL
NONPAREIL
Turbine Oil
STANDARD OIL COMPANY (INDIANA)
STANDARD

IS YOUR PLANT OPERATION SUFFERING FROM WATER TREATMENT PROBLEMS... *in the Generating System?*



Serious curtailing of output and decreased efficiency may result from deposits and/or corrosion on the steam-water side of the generating system.

Superheater—The chief problem encountered is deposits from carryover, which often cause tube burn-outs and lost efficiency. High temperatures, especially in localized areas, may lead to "dissociation" of the steam with resulting corrosion.

Turbine—Deposits from carryover are the main concern. In recent years, with increased pressures and temperatures, attention has also been directed to deposits due to vaporization of silica from boilers. Deposits of any kind may result in decreased capacity and efficiency, and often lead to frequent shutdowns for cleaning.

Condenser—On the steam side, serious problems are seldom encountered. However, corrosion may occur under certain conditions and deposits of iron oxide may form.

Condenser—On the water side, problems are more pronounced. In addition to deposits of "scale," other troublesome formations are slime and algae. Any of these deposits may decrease heat transfer with resultant loss of efficiency.

In order to correct these difficulties careful analysis of each problem is required. Corrective measures may range from simple chlorination, in the case of condensers, to complete boiler water treatment where deposits have formed in superheaters and turbines. Special water treatment measures may be required to eliminate vaporization of silica.

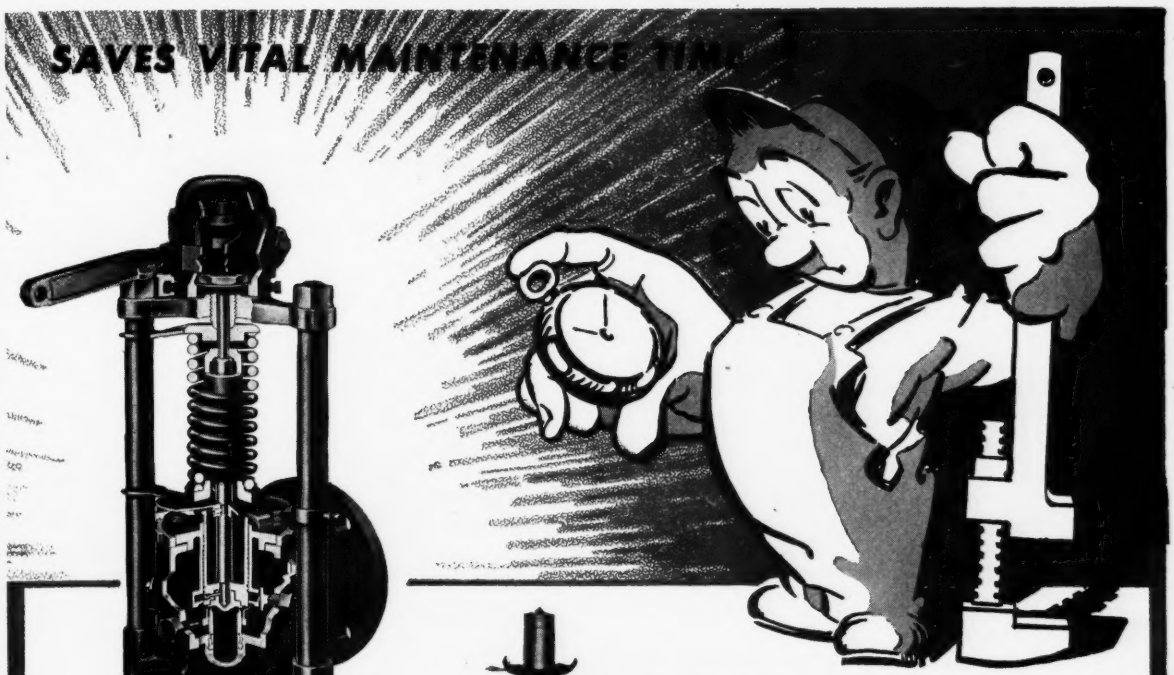
Some of these difficulties are probably present in your plant. Your local Drew Engineer will be glad to call and discuss your problem. No obligation.

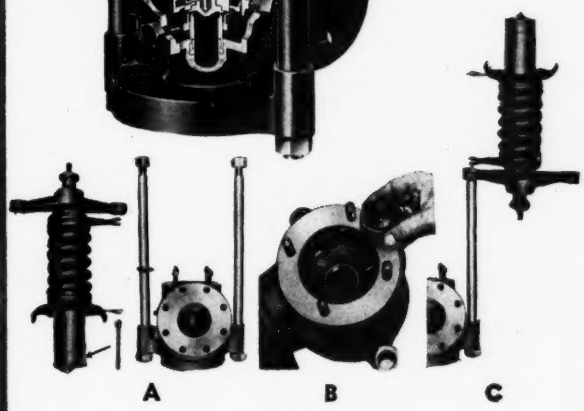
POWER **DREW** CHEMICALS

E.F.DREW & CO. INC.
15 E. 26th ST., NEW YORK 10, N. Y.
Representatives in all key cities

BOILER WATER TREATMENT
COOLING WATER CONDITIONING

The Foster 38-SV SAFETY VALVE





A. For inspection on boiler outage, the loading assembly can be locked and lifted out as a unit — inspected — serviced — and reassembled — without disturbing the spring setting. This saves time-consuming trial popping and resetting and cuts precious downtime.

B. With the loading assembly removed, the flat seating surfaces of both nozzle and disc are readily accessible, and in most cases can easily be lapped ON THE JOB with a simple ring-shaped lapping block. For this operation, loading assembly may be inverted and securely mounted on frame rod. It is unnecessary to take it to the shop.

C. When it is necessary to change the setting on the 38-SV, it can be done without waiting for the valve to cool between pops. Because of the frame rod construction, temperature change of the valve body has little or no effect on the loading mechanism.

Adjustments of nozzle ring, of guide ring, and of metering valve can all be made from the outside, while the valve is under pressure. All these adjustments lock. Piston freedom can also be checked by hand or with a screw driver while the valve is under pressure.

Other advantages are . . . tight seating . . . consistently accurate popping . . . high capacity . . . minimum blow-down which can be held to as little as 1%.

For full details on the design and construction features that enable this valve to out perform any other safety valve, get in touch with your Foster Representative or with us direct. Ask for Bulletin 25A.

Booth 84
at the Power Show

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . AUTOMATIC STOP AND CHECK VALVES . . . ALTITUDE VALVES . . . DAMPER REGULATORS . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . LIQUID LEVEL CONTROLLERS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN AND TRIPLE DUTY VALVES . . . VACUUM REGULATORS OR BREAKERS . . . SIGHT FLOW BOXES . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

111 MONROE STREET • NEWARK 1, N. J.

Answering a reader's question on smoke and soot conditions, the BERGEN ENGINEER, official organ of the Bergen County Chapter of the N.A.P.E., replied in a recent issue

> *". . . Any stoker will burn any kind of coal after a fashion, but only coal of definite characteristics* EFFICIENTLY . . ."

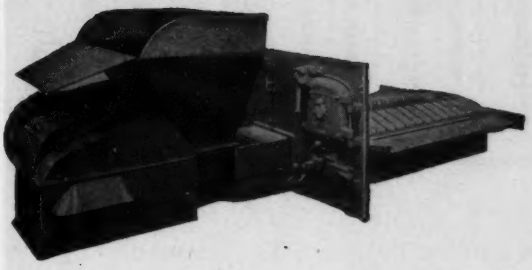
The coals that are available to *you* are the coals you are interested in. The stoker that will burn *those* coals efficiently is your natural requirement. And C-E supplies that need with the most complete line of stokers available *anywhere*. Here you are free to choose, from all basic types, the stoker that exactly fits your three-way problem of fuel characteristics, load and operating conditions. No need to settle for a compromise that will burn your coal "after a fashion".

Getting the *right* stoker is more important than ever today as coal costs rise, for the cost of fuel burned soon far outweighs the original equipment cost. Careful selection of stokers means dividends in dollars as well as operating satisfaction. Let C-E engineers help you in this choice. More than 19,500 C-E stokers, serving all industries and burning every type of coal, provide an impressive background of experience. And C-E's *complete* line assures you an unbiased recommendation . . . the experienced judgment of a manufacturer that has no axe to grind. B-246

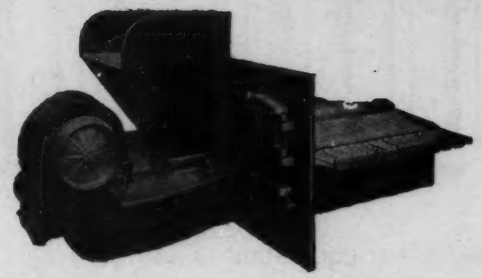
C-E

COMBUSTION E

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS, ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

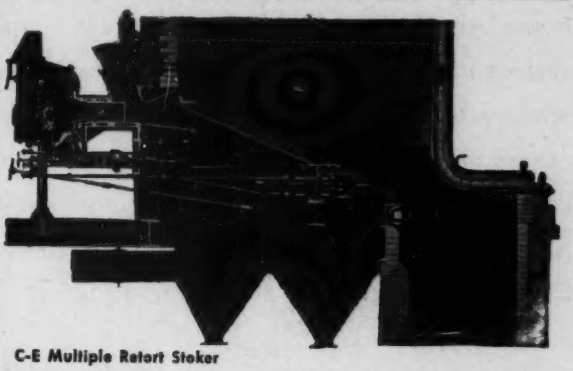


C-E Skelly Stoker

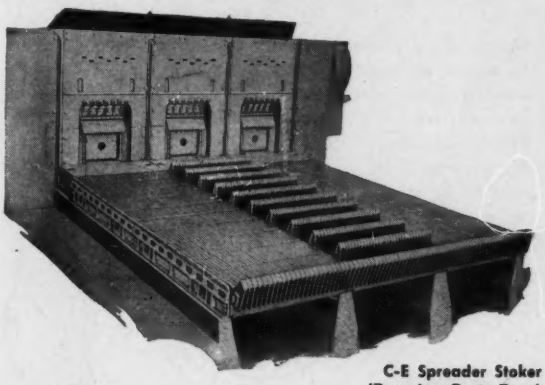


C-E Low Ram Stoker

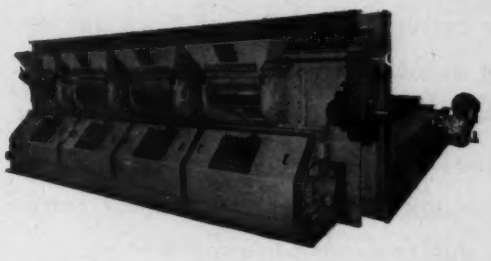
C-E Type E Stoker



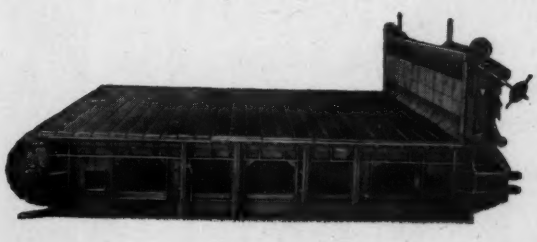
C-E Multiple Retort Stoker



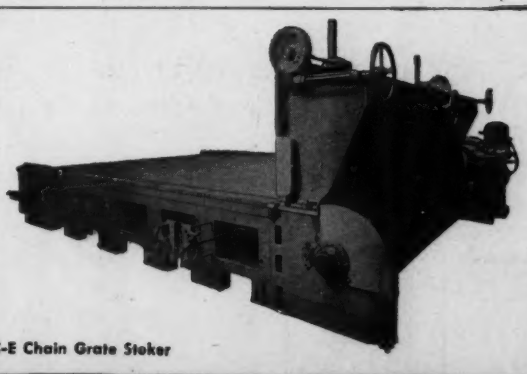
C-E Spreader Stoker
(Dumping Grate Type)



C-E Spreader Stoker
(Continuous Discharge Type)



C-E Traveling Grate Stoker



C-E Chain Grate Stoker

C-E ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

OUT-OF-DOORS

Power plant equipment is out-growing the confines of the conventional "boiler house" these days. Building costs are a serious bar to expansion in many cases, while adjacent space is unavailable in others. Therefore any equipment that can be installed outdoors offers welcome relief to overloaded generating plants. Cochrane Deaerators and Deaerating Heaters can be designed to suit practically any space requirement indoors, and when indoor space is not available, may be installed outside, as shown in the photographs on the opposite page. Suitably lagged, these may be installed outside in any but the coldest climates with no impairment of operation.

(upper left) Cochrane Deaerator and Horizontal Storage Tank installed outside plant of Millville Mfg. Co., Millville, N. J.

(upper right) 220,000 lb/hr. Cochrane Metering Deaerator mounted on roof of Scott Paper Co. plant, Chester, Pa. Storage tank is located inside building on floor below.

The extreme flexibility of Cochrane design as well as the inherent efficiency of the Cochrane principle of deaeration make it the most popular equipment for the protection of boiler plants against corrosion due to oxygen-bearing feedwater.

Many illustrations similar to these as well as more conventional installations are shown in Cochrane Publication No. 3005. A copy will be sent to anyone interested

COCHRANE CORPORATION
85 YEARS OF SERVICE
1863 - 1948

COCHRANE CORPORATION
3123 N. 17th Street, Philadelphia 32, Pa.

COCHRANE CORPORATION ★ PENNA.

COCHRANE

DEAERATORS and DEAERATING HEATERS

(above) 900,000 lb Deaerator, storage tan Vacuum Oil

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Millville,

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n roof of
Paper Co.
, Chester,
Storage
is located
e building
oor below.

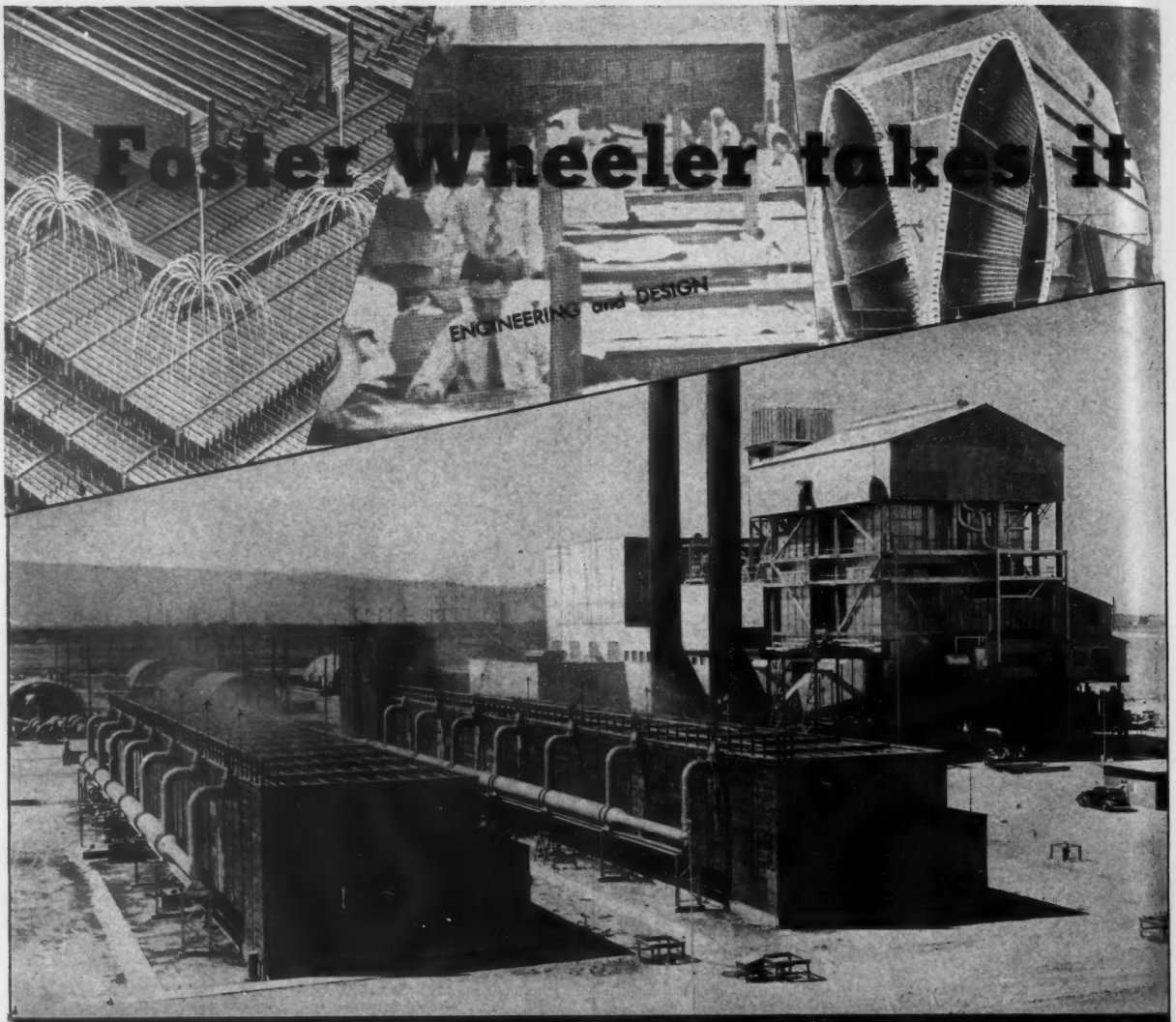
75,000 lb/hr. Cochrane Metering Deaerator installed outside boiler plant, in courtyard of Philadelphia's City Hall.

(above)
900,000 lb/Cochrane Atomizing Deaerator, mounted on horizontal storage tank at plant of Socony-Vacuum Oil Co. at Paulsboro, N. J.

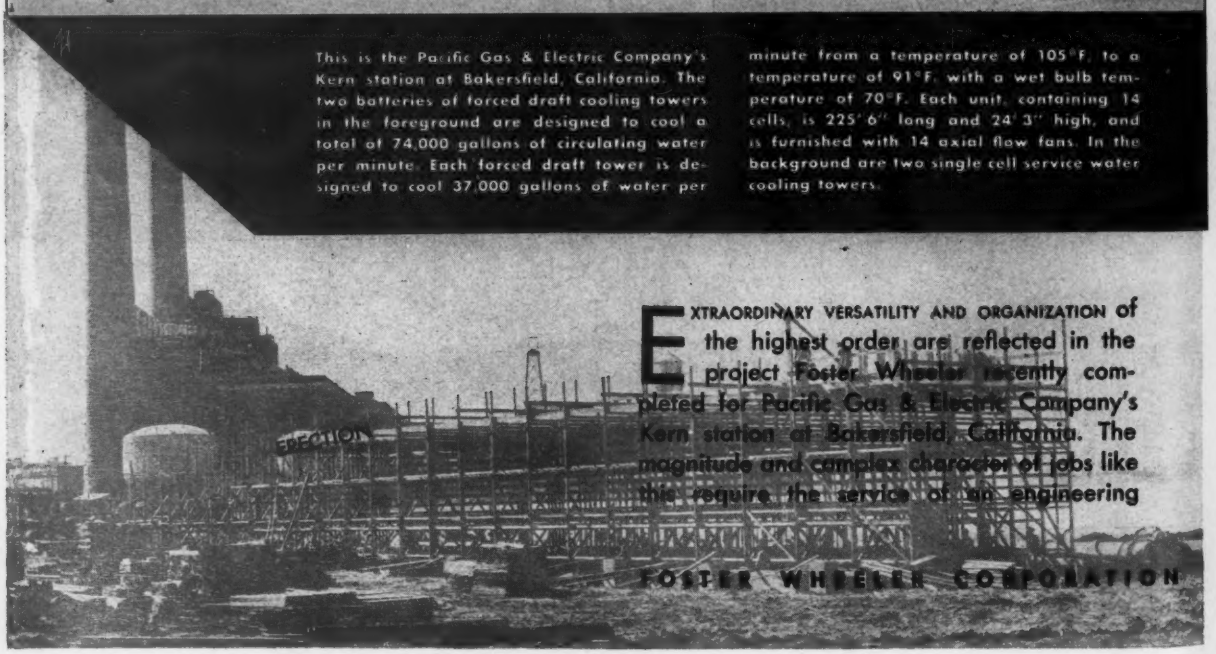
(center)
Two Vertical Cochrane Deaerators located at Rio de Janeiro, Brazil.

XUM

Foster Wheeler takes it



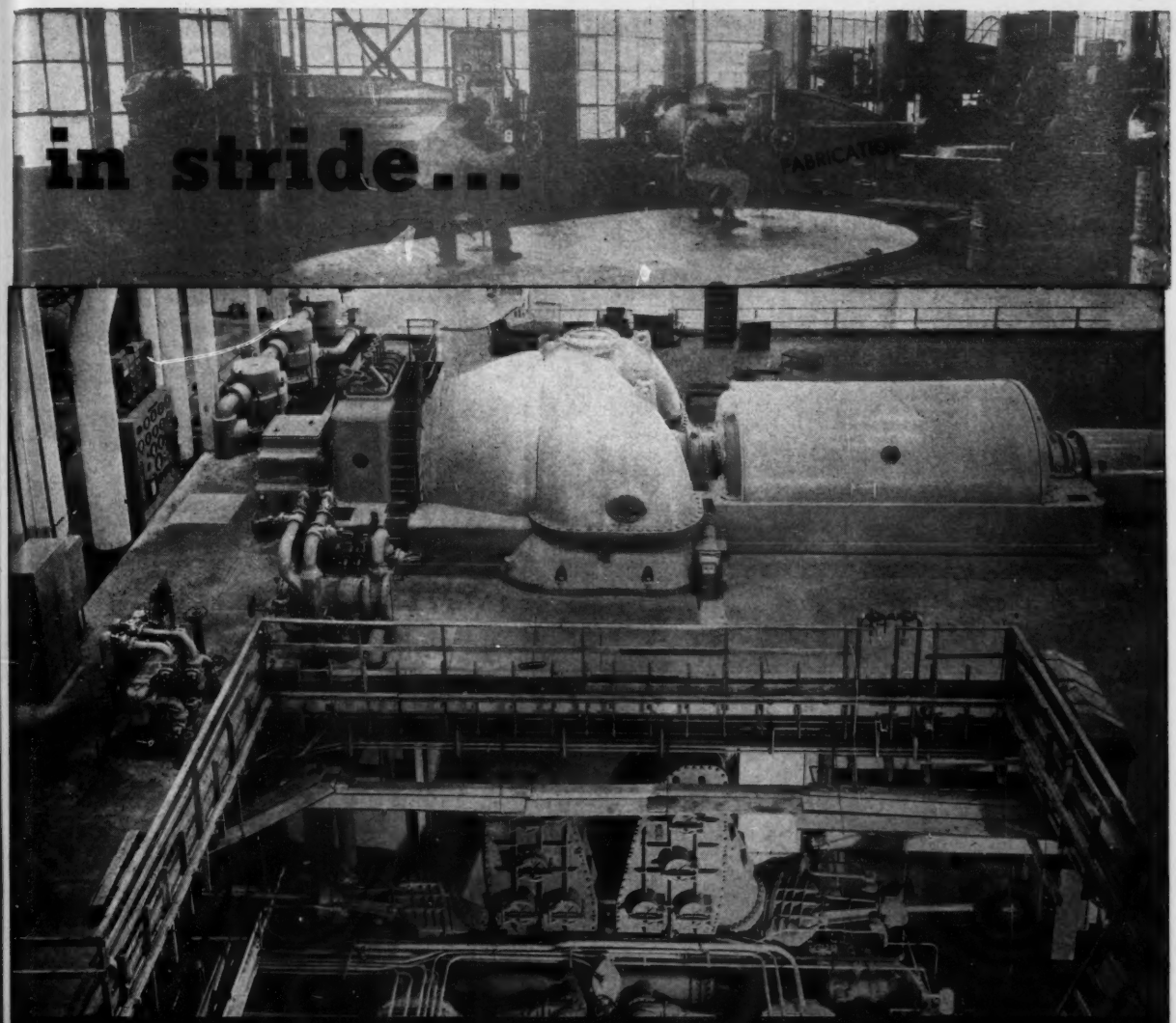
This is the Pacific Gas & Electric Company's Kern station at Bakersfield, California. The two batteries of forced draft cooling towers in the foreground are designed to cool a total of 74,000 gallons of circulating water per minute. Each forced draft tower is designed to cool 37,000 gallons of water per minute from a temperature of 105°F. to a temperature of 91°F. with a wet bulb temperature of 70°F. Each unit, containing 14 cells, is 225' 6" long and 24' 3" high, and is furnished with 14 axial flow fans. In the background are two single cell service water cooling towers.



EXTRAORDINARY VERSATILITY AND ORGANIZATION of the highest order are reflected in the project Foster Wheeler recently completed for Pacific Gas & Electric Company's Kern station at Bakersfield, California. The magnitude and complex character of jobs like this require the service of an engineering

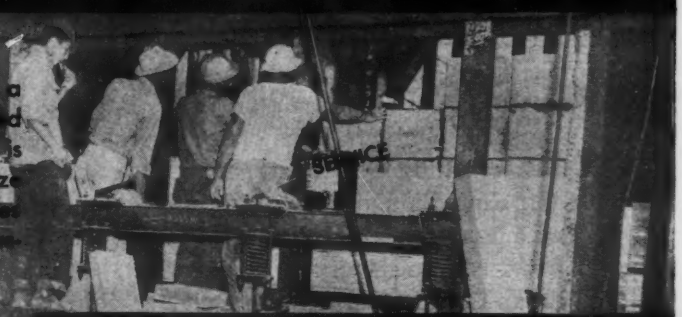
FOSTER WHEELER CORPORATION

in stride...



The divided water box condenser shown above serves a 60,000 kw turbine unit at the Kern Plant. The condenser has an effective length of 26 ft., and contains 35,000 sq. ft. of surface. The cross flow design, providing a central steam lane between the two banks, permits the best possible supply of steam to the hotwell for deaeration and reheat of the condensate. Circulating pumps receive water from the forced draft cooling towers and deliver it to the condenser and back to the cooling tower for re-cooling. Condenser auxiliaries include a 2,000 gallon storage hotwell, twin-element, two-stage steam jet air ejectors, hogging and priming jets, three-stage centrifugal hotwell pumps, and the circulating pumps mentioned above.

organization which knows how to handle a job from the proposal stage to the finished construction. The fact that Foster Wheeler is geared to keep many projects of equal size and larger going at the same time indicates the scope of FW's engineering and manufacturing capabilities.



165 Broadway, New York 6, N. Y.

FOSTER FW WHEELER

You have known this nameplate for 30 years

Now—get acquainted with this one

For nearly a generation the Hagan name on a control panel has been the mark of *dependability*—of a combustion control system that is simple, rugged, accurate, functioning day after day and year after year with a minimum of maintenance.

The same characteristics of simplicity, ruggedness and accuracy, with their resulting *dependability and low maintenance* are found in Hagan Ring Balance Flow Meters.

Our engineers will be glad to show the advantages of Hagan control and Hagan metering in your plant.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

XUM

C. H. Wheeler

XUM

50,000 Sq. Ft., 2 Pass Reverse Flow Condenser Under 60,000 K. W. Steam Turbine

A certain large public utility (name on request) faced the problem of leaves, trash and other refuse in their only available supply of condenser circulating water. They could have installed a standard condenser, but they found many advantages, including money saving, in selecting a C. H. Wheeler Patented "Reverse Flow" Condenser. Periodic reversal of water flow automatically cleans the tubes and tube sheets of this condenser, without loss in efficiency. Installation was simplified with the C. H. Wheeler "Reverse Flow" because it does not require any additional piping over that of a standard condenser. Photo shows this installation nearly completed. Note the two C. H. Wheeler Circulating Pumps which partly show in the foreground; also the Cross Over Valve for operation with one circulating pump. Condenser is equipped with C. H. Wheeler Steam Jet Ejectors and C. H. Wheeler Condensate Pumps. Write for more information about "Reverse Flow" or Standard "Dual Bank" Condensers, described in Catalog No. 1461.

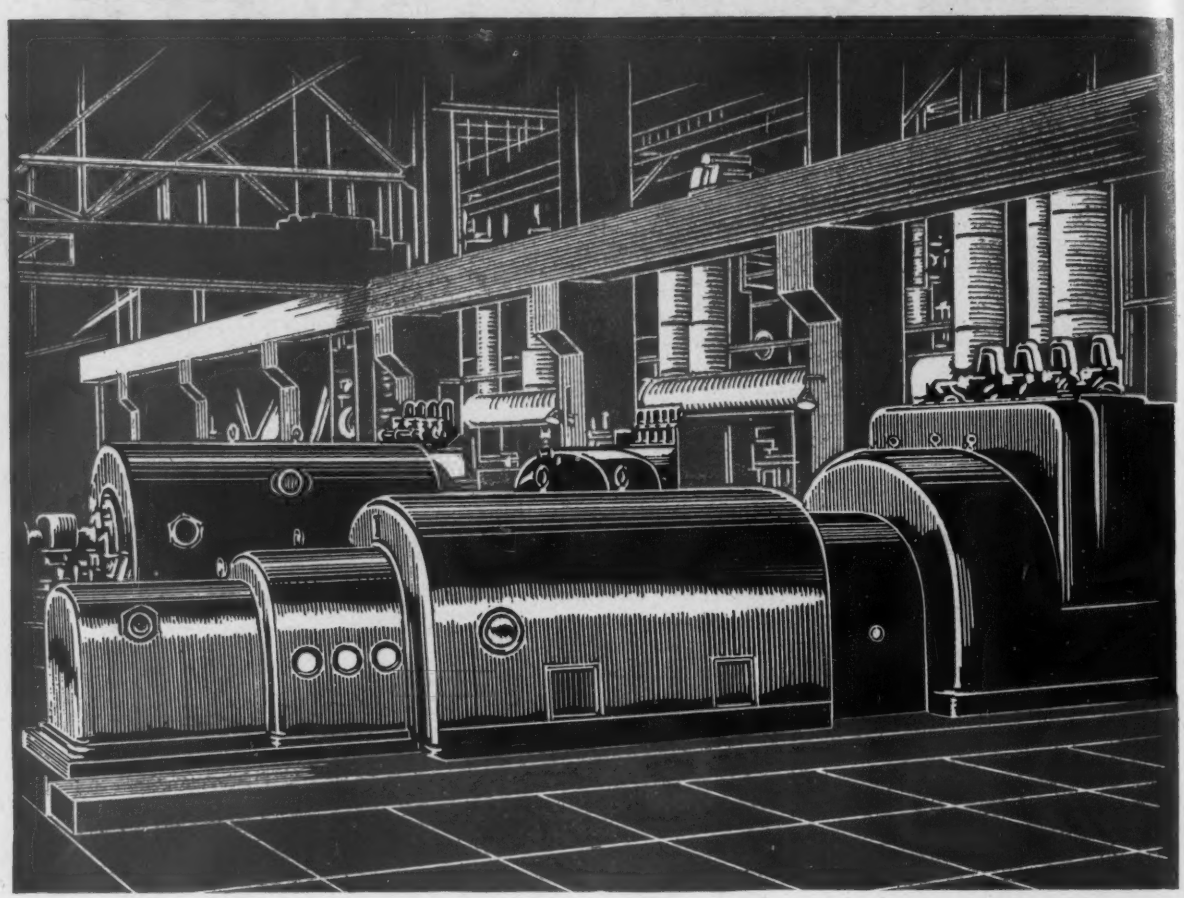
C. H. WHEELER MANUFACTURING CO.
1802 Sedgley Avenue, Philadelphia 32, Penna.
REPRESENTATIVES IN MOST PRINCIPAL CITIES

Right—C. H. Wheeler Induced Draft Water Cooling Tower built with steel casing, as illustrated, or entirely of redwood. Circle—Tubejet Steam Jet Ejector for power plant service; also one to five stage units for process application. Catalogs on request.

TEAM CONDENSERS • WATER COOLING TOWERS
JECTORS • STEAM JET VACUUM REFRIGERATION
OF PHILADELPHIA

XUM

YES! Tycol Aturbrio Turbine Oils perform better . . . BETTER . . . BETTER



Tycol Aturbrio Turbine Oils perform better because:

. . . *Tycol Aturbrio Oils* mean economical and more efficient lubrication plus positive protection against corrosion and rust.

. . . *Tycol Aturbrio Oils* are characterized by exceptionally good oxidation stability and demulsibility . . . they put an end to sludging troubles.

. . . *Tycol Aturbrio Oils* are justly famous for their dependability and endurance . . . have performed superbly in many plants for years without a change.

Complete and detailed information on Tycol Aturbrio Turbine Oils is available from your nearest Tide Water Associated Office. Call or write in today.

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
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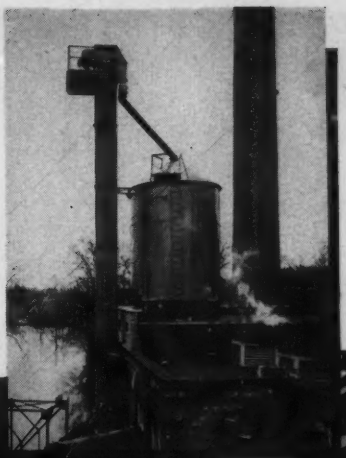
TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N.Y.

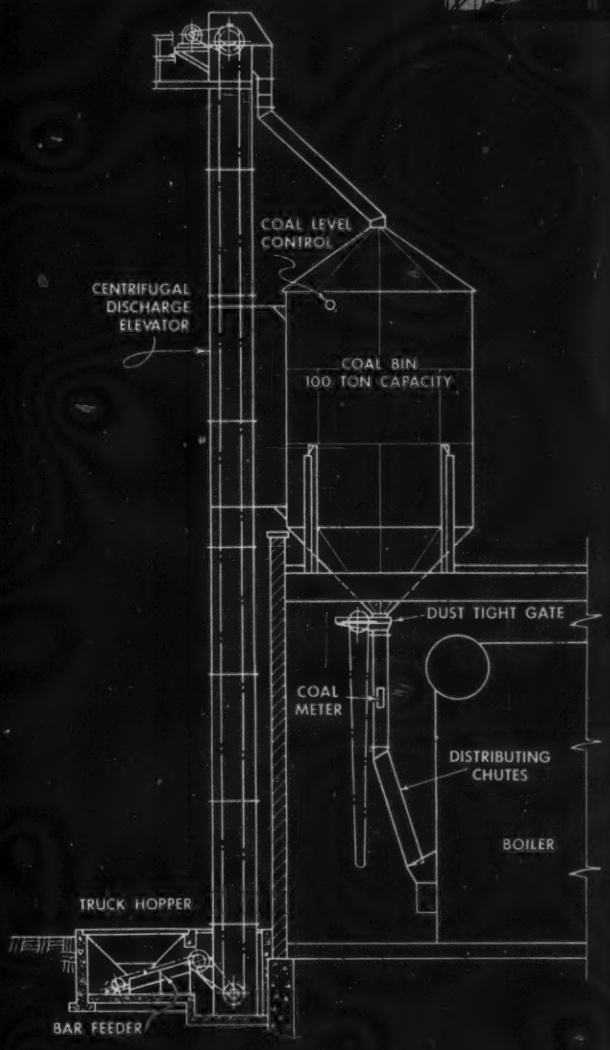
LUBRICATION — "ENGINEERED TO FIT THE JOB"

IN THIS CASE
tight quarters saved dollars



G-W Bucket Elevator and Steel Bin on Roof of Braendly Dye Works.

G-W Tri-furcated Distributing Chute Feeding Coal Directly to Stokers from Bin above Boiler Room.



When Braendly Dye Works, Inc., at Beacon, N.Y., modernized their steam boiler plant, a mechanical coal-handling system was required to replace the old, slow manual method. A G-W engineer was called in... recommended the elevator-storage system illustrated.

A river bank restricted ground storage space... a disadvantage that G-W ingenuity converted into economies. A live storage, steel bin was designed and mounted on roof directly over boiler room. Coal is supplied to bin by a bucket elevator and fed continuously by gravity directly to stokers. Warm boiler room air surrounds bottom cone of bin... prevents coal freezing.

Elevator boot is fed by bar type feeder which permits a truck hopper shallow enough to safeguard against flooding when river is high.

G-W took over *this* complete job ... from design through construction and erection...shouldered all responsibilities. G-W's complete engineering service is yours for the asking.

4388-A

G-W HANDLES IT...
faster • easier • cheaper

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CHICAGO 6
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VISIT BOOTH No. 6

National Power Exposition

November 29 to December 4

VALVES

Regulating—Pressure Reducing

All Republic valves are engineered to the specific job on which they are used. Cylinder operated valves are available in sizes from 3 in. to 24 in. Hand operated valves in sizes from 1 in. to 8 in. Lever operated valves in sizes up to 16 in.

Republic valves are built in all pressure standards—both flanged and welded ends. Streamlined flow through parts virtually eliminates erosion.

REGULATORS

Pneumatic and Hydraulic

Republic pneumatic or hydraulic type regulators are supplied for the automatic control of pressure, rate of flow, speed of rotation, liquid level, or the proportioning of two pressures, flows, etc., in a fixed ratio.

They measure the quantities they control regardless of the application. They can be made sensitive to changes of less than 0.002 in. of water.

DESUPERHEATERS

For All Requirements

Republic desuperheaters are built to meet your specific requirements. Whatever your plant conditions, you can obtain the necessary operating flexibility and accurate regulation of steam temperature with rugged, simply-controlled Republic desuperheaters.

These are of the venturi type with ratio control, the steam atomizing type and the mechanical atomizing type.

REPUBLIC FLOW METERS CO. 224

BOILER CONTROLS • INSTRUMENTS • PROCESS CONTROLS

The Republic Flow Meters Co. offers a complete manufacturing and engineering service in the field of measurement and control. We will be glad to co-operate with you in the solution of any metering or control problem, whether it involves a single instrument or the automatic control of an entire process or plant.

Republic engineers, in co-operation with your own engineers, will be glad to study your problem and make recommendations as to the most practical solution. Your inquiries will involve no obligation on your part.

BOILER CONTROLS

For All Types of Boilers

Republic offers a centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler water level, etc.

Automatically regulates the fuel and air imput to a boiler in measured proportions and in a fixed ratio for the entire load range. Available for all sizes of boilers and all types of fuel firing.

FLOW METERS

Electrical and Mechanical

Republic electrical type remote reading flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for line pressures up to 10,000 p. s. i. and for all ranges of differential pressures.

Mechanical ring-balance meters are built for static pressures up to 2500 p.s.i. and to operate on differentials as low as 3 in. of water.

BOILER METERS

Record Steam Flow—Air Flow

The Republic boiler meter records simultaneously on one chart the steam flow from the boiler and the rate of air flow to the furnace for combustion.

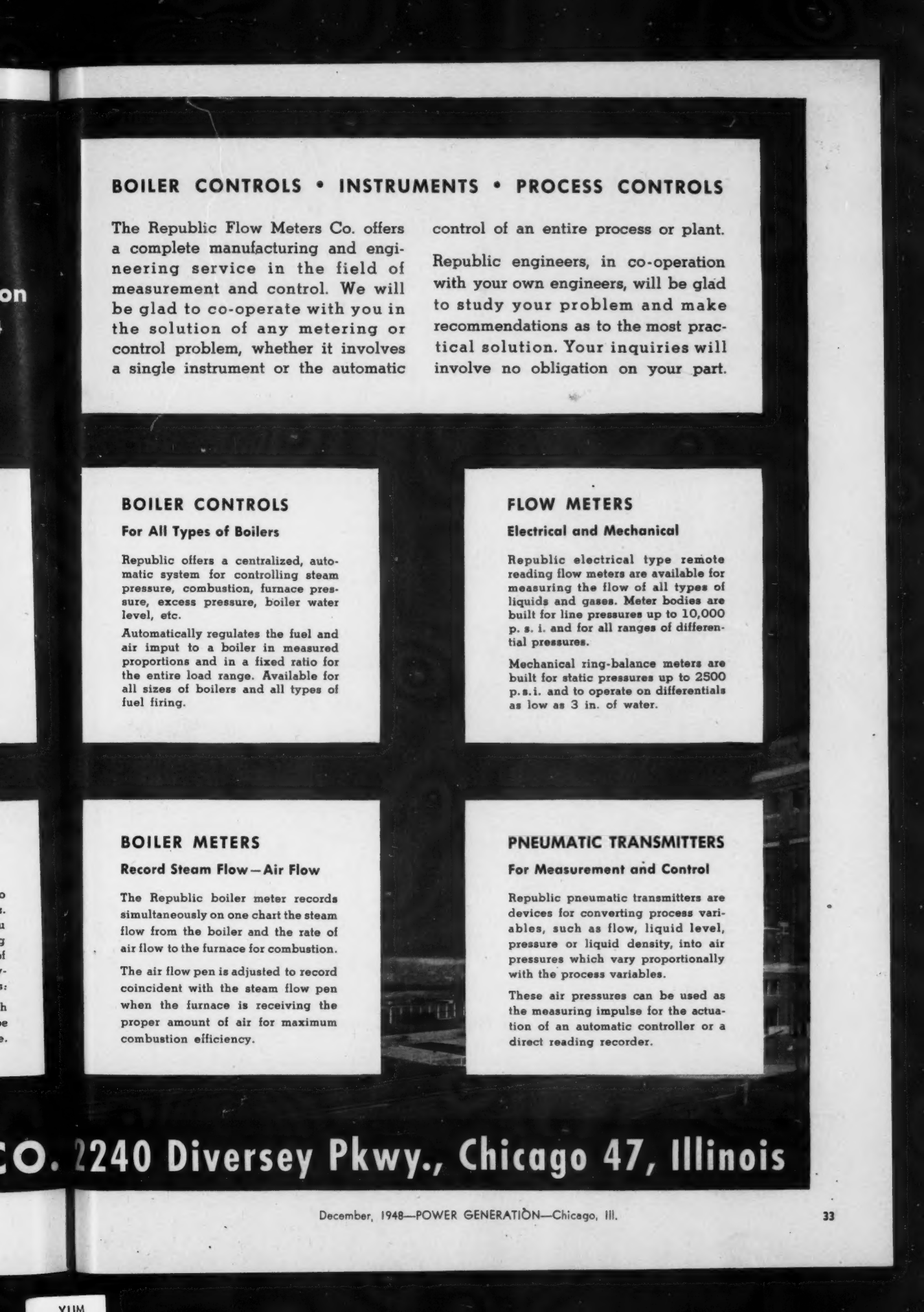
The air flow pen is adjusted to record coincident with the steam flow pen when the furnace is receiving the proper amount of air for maximum combustion efficiency.

PNEUMATIC TRANSMITTERS

For Measurement and Control

Republic pneumatic transmitters are devices for converting process variables, such as flow, liquid level, pressure or liquid density, into air pressures which vary proportionally with the process variables.

These air pressures can be used as the measuring impulse for the actuation of an automatic controller or a direct reading recorder.



CO. 2240 Diversey Pkwy., Chicago 47, Illinois

1. PURE DISTILLED WATER has no dissolved solids; produces big steam bubbles that burst instantly at surface as shown in Nalco Laboratories test tube boiler.

2. BOILER WATER has high dissolved solids; small bubbles with foaming tendencies cause carryover and impure steam.

3. BOILER WATER WITH NALCO ANTIFOAM Treatment —same water as in Photo No. 2 —now produce large bubbles without foam and pure steam ...the same results as distilled water.

Photos in Nalco Laboratories — unretouched.

TH *Nalco* ANTIFOAM TREATMENT

NALCO Antifoam Chemicals, used as a part of Nalco System Water Treatment, consistently produce steam with only 1 to 3 parts per million solids content — and frequently permit more than double the dissolved solids in the boiler water without danger of carryover!

Truly dry steam is a welcome and valuable protection for turbines, pumps, and the entire steam system ...and Nalco Antifoam Treatment makes a simpler problem of control of boiler water dissolved solids, since it prevents carryover at concentrations far exceeding average practices.

Your Nalco Representative can show you copies of actual steam quality charts that are typical of the *before* and *after* performance of Nalco Antifoam Treatments — *but the best proof is in your own boilers* ... Call or write, today.

... and PRECISION-CONTROLLED BLOWDOWN

● Precision control of boiler blowdown is assured with the Nalco Meterblo Valve...Large, easy-to-read settings ... quick-opening and closing...can be mounted in 16 different positions without special fittings. Now available through your Nalco Representative . . . or write direct.

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6224 West 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem, Limited Burlington, Ontario, Canada

Nalco

STEM • Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

BOILERS, AUXILIARIES, CONDENSERS

1 **Heat Insulation for Industry**—This 16 pp., bulletin provides in tabular form; selection guides, condensed specifications, heat losses through furnace walls, conductivity graph, performance data, and selection of cements. Also discussed are other products for insulating. Philip Carey Mfg., Co.

2 **Steam Boiler**—Bulletin 505 describes a packaged steam boiler unit. Photographs show the equipment which is an integral part of the boiler and drawings and a table list the dimensions and specifications of the unit. Johnson Brothers, Inc.

3 **Double Runner Attrition Mill**—Data Bulletin DRC- 1, 4 pp., describes and illustrates applications, fineness of grind, and construction data of the mill. Dimensions, power data, weights, volumes, performance data, are given in tables. Parts list with drawings provided. Sprout-Waldron & Co.

4 **Zig Zag Heat Exchanger**—Bulletin ZC, catalog sheet, explains briefly the heat exchanger of zig zag construction. Unit is intended to recover heat from waste process steam and water. David Stout & Sons.

5 **Direct Fired Unit Heaters**—This 4 pp., bulletin describes and depicts the application of these floor mounted unit heaters which employ the counter flow principle. Lee Engineering Co.

6 **Condenser Tube End Inserts**—This 8 pp., bulletin contains the report on these inserts by a testing organization as well as flow diagrams, fluid friction charts, and installation sketches. Condenser Service and Engineering Co., Inc.

7 **Two Cycle Radial Dual Fuel Engine**—Bulletin 155, 6 pp., describes and illustrates with photos, drawing, and disassembly photo this engine which is something new in stationary practice. Engine develops 1800 hp. Lubrication and other points discussed. Nordberg Mfg. Co.

8 **Jet Blowers**—Steam jet blowers and blast nozzles for moving large volumes of gas at low drafts are described in Bulletin 4-AB. Tables, charts and drawings give complete data on dimensions, connection sizes, capacities and costs. Colored diagrams, with explanations, are used to illustrate typical applications of various types of blowers and blast nozzles. Schutte & Koerting Co.

INSTRUMENTS

9 **Remote Controls**—Bulletin No. 800-B, 16 pp., describes the various manual and automatic remote control applications of expansible tube valves. Manual includes data and diagrams of typical arrangements. Grove Regulator Co.

10 **Gas Analyzers**—Bulletin No. 213, 8 pp., describes and illustrates the construction and application of these analyzers. Step-by-step sampling procedure is shown. These are intended for CO, CO_2, O_2, H_2O, and Methane. Burrell Technical Supply Co.

11 **Recording and Indicating Pyrometers**—Catalog No. 1101J, 40 pp., describes and illustrates with application photos, disassembly photos the recording and indicating pyrometers and potentiometers offered. Specifications for each are given. C. J. Tagliabue Corp.

12 **Sewage Treatment Instrumentation** Bulletin No. 7301, 43 pp., presents both applications and instruments with schematic drawings, photographs, and dimensional drawings. Instruments are: electric and mechanical flow and liquid level meters, pneumatic remote transmission systems, thermometers, pressure gages, recorders and indicators and others. Brown Instrument Co.

13 **Flow Measuring Tubes**—Bulletin A5, 8 pp., combines cut-away views and engineering drawings to describe in detail the principle on which flow tubes operate. Curve and logarithmic charts illustrate calibration. Bethlehem Foundry and Machine Co.

14 **Electronic Controls**—Bulletin Z6500, with price list, 8 pp., is condensed catalog describing and depicting indicators, controllers, recorders and combustion safeguards. Wheelco Instruments Co.

15 **Smoke Recorders and Overfire Jet Controls**—Bulletin No. 20-A, 8 pp., describes and illustrates profusely with photos dimensional drawings, and sketches the electronic smoke indicators, recorders and overfire air jet controls. Brooke Engineering Co., Inc.

16 **Multi-Record Recorder**—Bulletin 428 tells about this company's Dynalog Recording instrument. Colored illustrations depict graphically what happen when the recorder operates. Listings of advantages and uses of the instrument are given. The Foxboro Co.

17 **Transmitting Pressure Measurements Electrically**—Catalog R-10, 8 pp., contains detailed engineering and application data on indicating or recorder type instruments. Schematic sketches illustrate application to measuring variables such as density, flow, weight. Automatic Temperature Control Co., Inc.

18 **Air Actuated Control**—A complete air-actuated control system of advanced design is presented in this 24-page Catalog ND4B. Diagrams and test curves show how the system provides proportional action, automatic droop correction and stabilized rate action. Illustrations show many interesting features of the system. Leeds & Northrup Co.

ELECTRICAL

19 **Heavy-Duty Synchronous Motors**—Bulletin 1100-PRD-181, 8 pp., describes and illustrates these motors available for high speed operation from 30 to 5000 hp. Cutaway sections show features of construction. Phbtos show various parts. Electric Machinery Mfg., Co.

20 **Magnetic Starters with Circuit Breakers**—Bulletin 4130, 4 pp., describes and illustrates with photos and specification tables these combination a c magnetic starters with circuit breakers. Heater selection tables are given. Ward Leonard Electric Co.

21 **Insulated Wires and Cables**—Handbook and Catalog No. 10-F, 96 pp., illustrates and describes wires, cables, and flexible cords designed for use where wiring is exposed to heat, corrosive fumes, oil or fire hazard. Book contains Electrical Code data as applied to products. Rockbestos Products Corp.

22 **Synchronous Motors**—Bulletin GEA-5063, 4 pp., briefly presents the high and low speed synchronous motors for the lumber, pulp, and paper industries. Application photos show use of these motors in industries. General Electric Co.

23 **Transformers**—Transformers for all classes of service are now available with the company's non-inflammable insulating liquid, according to Bulletin 61B6043A. The bulletin points out how transformers filled with this liquid are especially suitable for installation in locations which would require a fireproof vault if other types of liquid were used. Allis-Chalmers Mfg., Co.

24 **Power Factor**—"Power Factor and What to Do About It," is a new 20-page, pocket-size booklet (No. 200-TEC-1077) explains the essentials of power factor in industrial plants, gives a digest of power factor calculations, why low power factor should be corrected and tells how it can be done. Electrical Machinery Mfg., Co.

25 **Installation and Care of Dry Type Transformers**—Bulletin 61X7068, 16 pp., covers unloading, installation, storage, drying coil and core, maintenance hints, and description of accessories and wiring diagrams for thermal control. Switch plate and terminations information is given. Sketches, photos and charts illustrate text. Allis-Chalmers Mfg., Co.

PIPING, VALVES, FITTINGS

26 **Welding Pipe Fittings**—An excellently done 24-page book on welding fittings for branch pipe outlets has just been issued. The manufacturer points out that the book shows the way to reduction in piping costs from 50 to 75 per cent. Three types of fittings are described for butt welding, threaded, and socket welding. In addition, complete installation instructions, sizes, dimensions, weights, list prices, temperature-pressure ratings and material specifications are given. Bonney Forge & Tool Works.

27 **Pump and Valve Applications**—This 16 pp., bulletin illustrates and describes applications in which the three divisions of this company have placed their equipment. These include, pumps, planers,

December, 1948

POWER GENERATION
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Chicago 4, Illinois

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and regulating valves. Hamilton-Thomas Corp.

28 **Application of Flexible Tubing**—This 6 page folder contains many application and construction photos to show the wide use to which flexible tubing may be adapted. Pennsylvania Flexible Metallic Tubing Co.

29 **Hydromatic Single Control Valve**—Bulletin 4460, 8 pp., describes and depicts the application of these valves to water treatment systems. Piping diagrams showing valve applied to three different types of systems are given. Cochrane Corp.

30 **Self-Flaring Tube Fitting**—This 4 pp., bulletin explains and illustrates the self-flaring action of this fitting with cut-away views. Drawings show kinds of fittings available. Scovill Mfg. Co.

31 **Expansible Tube Valves**—Bulletin 800-B, 16 pp., explains the construction and operation of these valves with numerous drawings, both cross-sectional and flow. Also depicted are the various types of controls and their piping arrangement to which valve can be applied. Photos show applications. Grove Regulator Co.

MAINTENANCE

32 **Metallizing Spray Wire**—Bulletin 57, catalog sheet, presents briefly the wire for metallizing guns. Recommendations for each type of gun are given. Metallizing Engineering Co.

33 **Building Maintenance**—Bulletin No. 10, 4 pp., describes the industrial protective coatings and paints for resisting the corrosive fumes of industrial atmosphere. Little hints and questions and answers to some problems are given. Truscon Laboratories.

34 **Bonding Cement**—This 6 pp., folder gives instruction on the application of this compound for bonding walls of concrete or plaster. Camp Co.

35 **Industrial Protective Coatings**—Bulletin MC-2, 4 pp., presents the typical applications for which this coating is suitable and lists the typical materials it resists. Back cover also lists other series of coatings. United Chromium, Inc.

36 **Corrosion Resistant Coating and Wrapper**—This bulletin gives complete details about a new roll product which combines a corrosion-resistant coating and wrapper for use on lead-sheath cable in manholes. Dearborn Chemical Co.

37 **Industrial Protective Coatings**—This 12 pp., bulletin gives detailed information on protective coatings to stop corrosion. Each product offered is listed with specifications and possible applications. Mixing and thinning instructions are included. Various types of applications are depicted. Tar Products Div., Koppers Co., Inc.

38 **Preventing Erosion in Condensers**—This 16 pp., booklet is a report for engineers interested in economies in power production and prevention of erosion from water in motion. Debevoise Co.

39 **Floor Care**—Prevention of "dusting", produced by trucking and hard wear on concrete floors, is explained in this new 6-p folder. The dangers of the dust are explained and the booklet tells how to use the product. Stonhard Co.

40 **Concrete Overlay**—Ruggedwear, this company's overlay compound for providing, durable, non-sparking, fireproof overlays for worn and damaged concrete, brick, stone, composition, steel or wood floors is described in this bulletin. The bulletin shows how the material is applied and lists its advantages. Flexrock Co.

PUMPS

41 **Centrifugal Pumps**—Bulletin 1020, catalog sheet, presents data on the general construction and capacities of this double ball bearing centrifugal pump. Yeomans Brothers Co.

42 **Condensate Pumps**—Catalog Section 199 describes this company's packaged condensate return units. Containing 4 pages, the section gives complete engineering and dimensional information and illustrates the units. Roy E. Roth Co.

43 **Corrosion Resisting Pumps**—Bulletin 815, 20 pp., describes the newest design features and illustrates with complete exploded views. Many cross-sectional views and drawings also serve to explain construction. Duriron Co., Inc.

FANS, COMPRESSORS

44 **Fan Data**—"Physical Proportions of Commercial Fans," is the title of a new 4-page booklet Form X-12. It has been produced by this Association as a service to architects, engineers, and others. The Form is used in conjunction with the NAFM's "Standards." National Assn. of Fan Manufacturers.

45 **Air Handling Equipment**—Catalog 481, 32 pp., contains information concerning equipment for dust and fume control, spray booths, washers, ovens, and others. Engineering tables and charts are presented on; gas friction, Area and circumference of circles, cfm through collecting hoods, weight of galvanized pipe, dimensions of wrought steel pipe, water discharge through orifices, and flow of gas through pipes in cfhr. Schmieg Industries.

46 **Standardized Compressors**—This 8 pp., bulletin is arranged to be folded out. Shown are the 48 different models which can be constructed from 18 parts. Also the special features of different parts which make this possible. Air-Flo Compressor Co.

47 **Bag Type Dust Collectors**—Bulletin No. 163-4, 4 pp., describes and depicts with cutaway view, dimensional drawing and table, and illustrations of certain parts, these standard bag type dust arrestors. Northern Blower Co.

TOOLS

48 **Electric Hammer and Drill**—Catalog sheet No. 485, describes the combination electric hammer and drill for drilling holes in concrete. Drill has detachable piece which converts it into a hammer. Specifications and prices are given. Wodack Electric Tool Corp.

49 **Electric Nut Setter**—Bulletin S8I, 4 pp., describes and depicts the many applications for this nut setter. Cross-sections show the construction and assembly. Speed-O-Matic Sales, Inc.

50 **Power Pipe Bender**—Bulletin No. 34, 8 pp., gives operating instructions on this automatic pushbutton ram bender of 2 in. capacity. Photos illustrate operation. Also shown are the different shape bars that can be shaped. Use in making coils, radiant heat installations is given. Wallace Supplies Mfg. Co.

51 **Handbook on Drills and Reamers**—Catalog No. 50., 225 pp., contains 45 pages of helpful technical data on the use of drills, tapers, drilling speeds, cutting oils, carbide tools, tap and pipe thread sizes. This section is really a hints and kinks help. Balance of handbook is made up of complete listing of all tools offered with prices. Request on company letterhead. Chicago Latrobe Twist Drill Wks.

52 **Machinists Tools**—This 29 pp., catalog presents the line of small tools for machinists and related jobs. In addition to a standard line of micrometers, calipers, height gages, there are several new tools listed. George Scherr Co., Inc.

53 **Combination Blast Gun**—This 6 pp., folder describes the applications for which this combination blast and spray gun is suitable. Some uses are sand blasting, liquid sprayer, cleaning carbon, rust and oxidation. Engineered Products, Inc.

MISCELLANEOUS

54 **Magnetic Pulleys**—Two new catalogs—Bulletins C-1001A and C-1007A—present a complete description of features and applications of electromagnetic pulleys and Alnico magnetic pulleys. Both catalogs were prepared as guides for magnetic separator users to help determine the type and size of pulley most suitable for specific requirements. Dings Magnetic Separator Co.

55 **Bulletin Catalog on Chemical Proportioning**—This 4 pp., bulletin presents short descriptions of the many bulletins available on chemical proportioning equipment. Proportioneers, Inc.

56 **Crawler Tractor**—Bulletin A-93-LL, describes, depicts, and presents specifications for, this medium size crawler tractor. Outstanding points of construction and operation are discussed. International Harvester Co.

57 **Vibration Control Data**—Bulletin G-101, 4 pp., discusses the advantages and limitations of spring mountings, rubber mountings, and cork materials in the control of vibration. Data on installation and uses is given. Provided is an excellent isolation mount selector chart. Korfund Co.

58 **Progress in Power**—Bulletin No. 3724, 20 pp., depicts the growth and use of power in this nation and illustrates the use of this firm's equipment in that growth. American Blower Corp.

59 **Self-Aligning Roller Bearing Units**—This 4 pp., bulletin contains information on this bearing which may be adjusted. These come in several styles. Shafer Bearing Corp.

60 **Packings**—Wood-Metal Packings is the subject of this booklet. Illustrations show how the packing performs over a period of years and the booklet tells about the various types of equipment and the types of chemicals and other media in which the packing may be employed. Installation instructions are given. Rains Wood-Metal Packings.

61 **Retaining Rings Data Book**—A data book which covers retaining rings used for the purpose of locating and positioning machine parts on shafts and in housings, has just been issued. The book contains 28 pages and is a compilation of engineering information and specification. The book is well arranged and tables are large and clear for ready reference. Truarc Div., Waldes Kohinoor.

62 **Castings in Industry**—"Nickel Alloy Steel Castings in Industry," is the title of this recently-issued 32-page book. The bulletin describes the uses to which this alloy has been put in various industries ranging from railroad equipment to mining and smelting and power plants. It is profusely illustrated. International Nickel Co., Inc.

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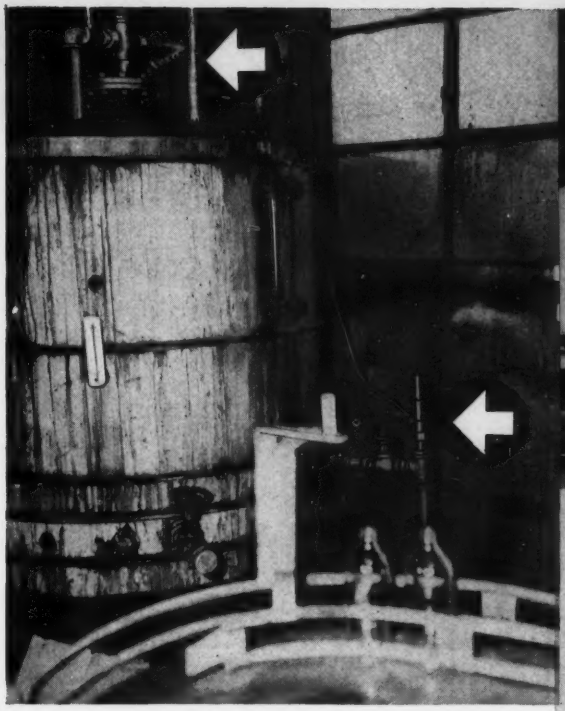
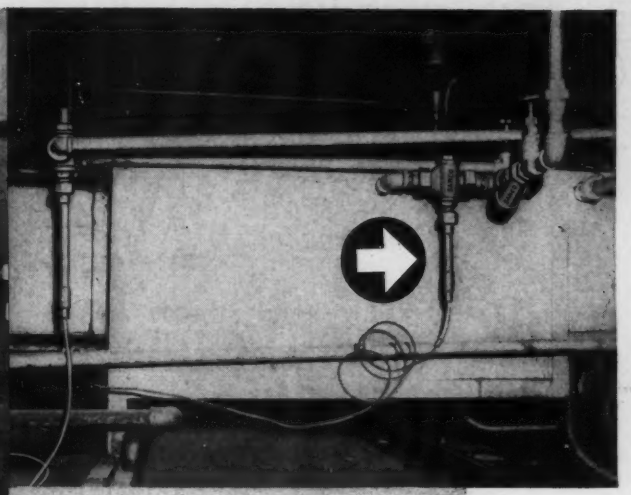
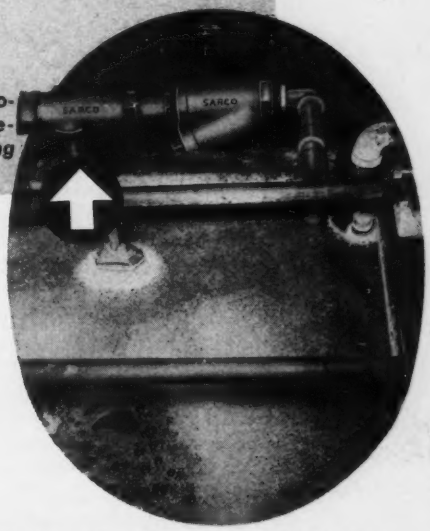




Sarco Controls on Proof Box in Bakery

Sarco 2430 Control on Vinegar Sterilizing Tank.

Sarco 87 Thermoton Reduces Rejects in Tin Plating Tank.



How Sarco REDUCES REJECTS . . .

Process heat is often applied toward the end of the production cycle. A rejected product at this point means lost materials, lost labor, and lost production—all gone forever with no salvage, as a rule.

Many hours of work are represented in the contents of the 1000 gallon per hour vinegar pasteurizer illustrated. Yet, with hand control the vinegar could scorch in a few minutes—or crack the jugs, and it did frequently.

In another part of this plant, old vinegar jugs are caustic-washed previous to being filled with commercial cleaning solution. Two out of six jugs were cracked with hand temperature control. Now all temperatures are controlled with Sarco—all products uniform, day in and day out, and spoilage is negligible.

Other Sarco controls are daily reducing the percentage of rejects in plating, baking (temperature and humidity controls) syrups and a hundred other chemical and food applications, and Sarco Steam Traps are reducing rejects in many industries by keeping heat up in every part of the coils.

231

SARCO

SAVES STEAM

SARCO COMPANY, INC.

Represented in Principal Cities

Empire State Building, New York 1, N. Y.

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ONE OF A SERIES • • • *Allis-Chalmers Water Conditioning*

Well known Dairies rely on Allis-Chalmers Sodium Zeolite Softeners

. . . TYPICAL OF A-C AID TO ALL INDUSTRIES FACED WITH WATER TREATING PROBLEMS

SUCCESSFUL dairies ordinarily can't spend time and effort to investigate their water conditioning problems. Instead, they work with a competent water treating organization to get help.

Allis-Chalmers in the water conditioning field provides not only a first hand study of water treating needs, but works right along with you in selecting the right process and correct equipment for your requirements — whether boiler feed water, cooling water, or process work.

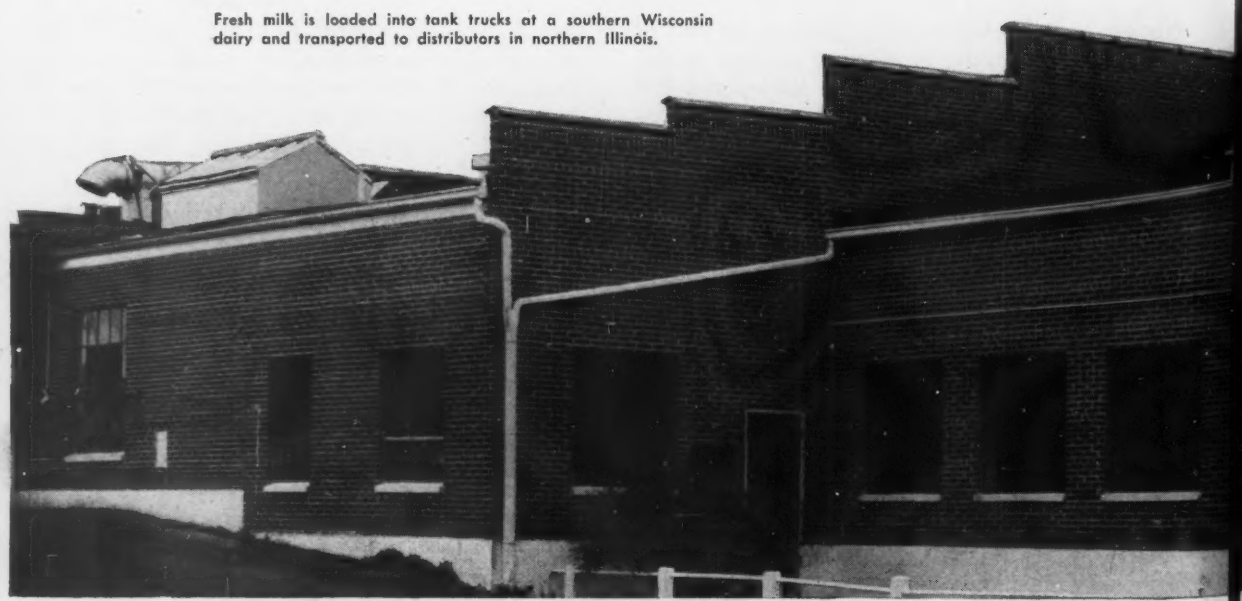
Allis-Chalmers Provides *Service, Chemicals, Equipment.*

SERVICE starts with a complete study of water supplies and impurities, surveys of present methods and plant operating conditions. Following this: recommendations, selection of chemicals, periodic reports, and service calls.

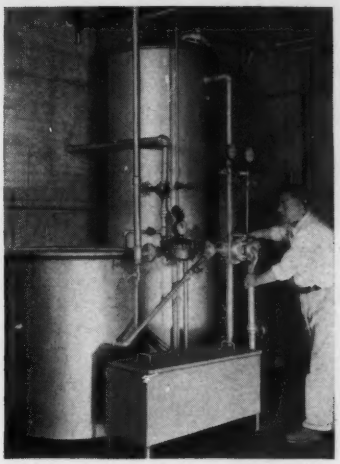
CHEMICALS comprise a complete new line of formulations for scale and corrosion control in all types of cooling towers and heat exchangers. Also the Reliable AKON and SILIMITE chemicals — AKON chemical for prevention of boiler scale and corrosion and SILIMITE chemical for silica reduction.

EQUIPMENT includes hot and cold process softeners, sodium and hydrogen zeolite softeners, degasifiers, deionizers, chemical proportioners, and oil removal and water filters.

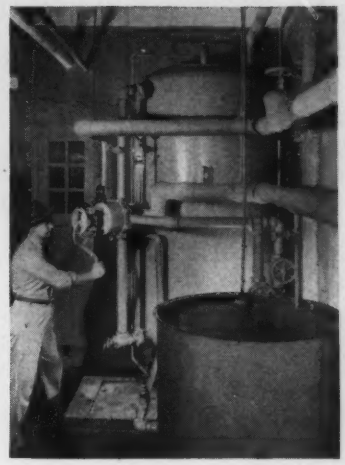
Fresh milk is loaded into tank trucks at a southern Wisconsin dairy and transported to distributors in northern Illinois.



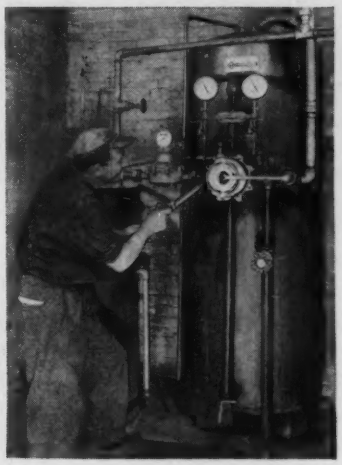
(SERVICE • CHEMICALS • EQUIPMENT) *at Work in Industry*



A 7,500 gal. zeolite softener installed at a Wisconsin dairy last year typifies many smaller installations in all industries. Softened water from this unit is heated to 190 F for the can washer. Softener also supplies feedwater to boiler for steam heating the building. Additional steam is used for evaporating and pasteurizing, as well as drying 2,800 lbs. of milk per hour.



This 9,000 gal. zeolite softener was installed at Wisconsin's world famous Pabst Farms dairy over three years ago. It treats extremely hard well water which boilers turn into steam at 150 psi for evaporating, pasteurizing and drying operations. Steam is also used to heat the dairy buildings where milk from 1,500 head of Holsteins is processed daily.



A 5,000 gal. zeolite unit recently installed at Dairyland Co-op in eastern Wisconsin keeps a 100 lb. boiler supplied with soft water to provide exceptionally clean steam for numerous dairy operations. In addition to heating the plant, pasteurizing, cooling, and can washing, steam is also used in the preparation and processing of various types of cheese.

AKON and *SILIMITE* are Allis-Chalmers Trade-Marks

ALLIS-CHALMERS

Water Conditioning Service . . . Chemicals . . . Equipment

JUST OUT—the new Allis-Chalmers Sodium Zeolite Bulletin!

Send for this simple yet thorough discussion of water hardness and the sodium zeolite softener. Fully describes applications, operation, controls, layout and piping!

A 2558

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MILWAUKEE, WIS.

Please send me Bulletin 7107

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Company.....

Title.....

City..... State.....

STANDARD ENGINEER'S REPORT

RPM CALOL

TEST DATA

UNIT G.E. 50,000 KW Steam Turbine - Horiz. Staple Compounds. Steam - 1250 lbs. - 750° F.

LUBRICANT Calol OC Turbine Oil - 9

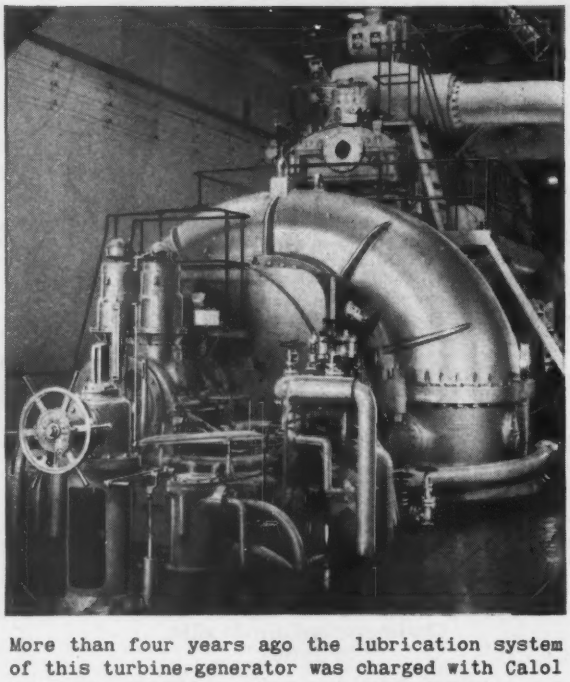
TEST PERIOD 4 Years —

CONDITIONS Operation of Generator

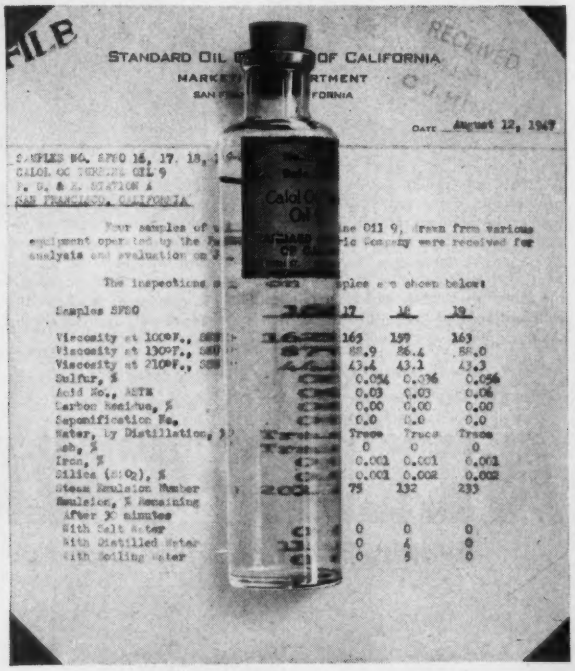
LOCATION San Francisco Station A

FIRM Pacific Gas & Electric Co.

SAME OIL CHARGE USED IN TURBINE FOUR YEARS SHOWS NO DETERIORATION



More than four years ago the lubrication system of this turbine-generator was charged with Calol OC Turbine Oil—9. After continuous operation on this same oil charge during all of that time, a laboratory analysis showed the oil had not increased in acidity or deteriorated. Inspection of lines, sumps, and governor control mechanism showed them to be clean and free of sludge and lacquer. Journals remained in good condition. Calol OC Turbine Oil resists both oxidation and corrosion.



Note how clear this sample of the Calol OC Turbine Oil charge remained after 4 years of use - figures can be read through it and there is no deposit at the bottom of the bottle. The actual specifications of the used oil from the turbine-generator is one of the four sets shown here.

REMARKS: Calol OC Turbine Oil is specially compounded to provide long service and give full protection to all vital bearing surfaces. It contains a highly effective oxidation inhibitor which resists the action of air, heat and moisture, preventing sludging and lacquer formation, reducing oil maintenance costs to a minimum. Its corrosion inhibitor and excellent metal-wetting ability stop rusting, even in initial operation of turbines. Calol OC Turbine Oil is made in five grades to meet various installation conditions.

STANDARD TECHNICAL SERVICE conducted and reported this test: If you have a lubrication or fuel problem, your Standard Fuel and Lubricant Engineer or Representative will give you expert help; or write Standard of California, 225 Bush Street, San Francisco 20.

Trademarks, "Calol," "RPM," Reg. U. S. Pat. Off.

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Quick
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plus anti-g

Mode
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Small size
panel only

Ease
element a

Why
found in a
boards, a
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XUM

engineering gives you

SPRING-MOUNTED JEWELS IN NEW
AB-15 and DB-15 SWITCHBOARD INSTRUMENTS

Greater Reliability

The accuracy and excellent performance of this new line of switchboard instruments is guarded by spring-mounted jewels. During handling, transportation, installation, severe overload, or remodeling of panels the jewels are protected. Shocks that might put ordinary instruments out of service are safely absorbed by these special spring mountings.

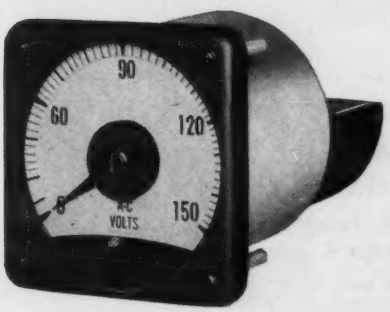
OTHER REASONS FOR INSISTING ON THESE INSTRUMENTS IN YOUR SWITCHBOARDS

Quicker, more accurate reading on the long 7.1-inch scale, spanning 250 degrees, with all figures reading laterally instead of on a curve. Anti-parallax scale and pointer, plus anti-glare glass make reading easier from angles.

Modern streamlined appearance. The attractive black Textolite cover, with circular mask covering the mechanism at center of dial, serves to emphasize scale and pointer. Small size (only 4½ inches square) permits mounting five instruments side by side on a panel only 24 inches wide.

Ease and economy of servicing assured by new "unit" design—entire moving-element assembly can be removed and replaced without disturbing calibration.

Why take less when you can get all these features—plus the many other refinements found in all G-E instruments? Insist on the G-E long scale line when ordering your switchboards, and be sure of the best. **Apparatus Department, General Electric Company, Schenectady 5, N. Y.**



Also available as a-c ammeter, a-c wattmeter, d-c voltmeter, d-c ammeter, temperature indicator, power-factor meter, synchroscope, and frequency meter.

GENERAL ELECTRIC

80Z-135

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NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

A **Smoke Tester.** An addition to its line of smoke measuring instruments — a simplified, hand-operated true-spot Smoke Tester, primarily for use in checking oil burners for clean firing has been announced by this company.

A smoke test is made with this tester by locking a paper test disc into the instrument, inserting the metal probe into a suitable hole in the smoke pipe, and drawing with six pump strokes a sample of the combustion gases from the furnace flue.

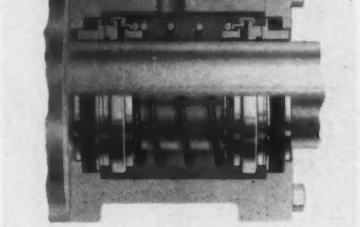
Drawing the sample through the tester will turn the test disc to a shade of gray which will vary from light to dark depending upon the smokiness of the flame. The disc is then removed from the tester and the soot content of the gas sample is measured by comparing the discoloration of the disc with nine shadings on a "Scale of Soot" which is supplied with the instrument. The "Scale of Soot" tells the limits of permissible smoke for various burners and types of heating systems.

The handle of the instrument is designed to hold a supply of test discs, so that they are protected, and conveniently at hand.

The instrument lists at $16.00, complete with 100 test discs and smoke scale. Bacharach Industrial Instrument Co.

B **Rotating Shaft Seal.** Advanced design and ease of installation are features attributed to a new rotating shaft seal, the "Roto-Flex." The seal is said to be suitable for such applications as water and oil pumps, fuel oil and gasoline pumps, water circulators, refrigeration compressors, speed reducers, and numerous other industrial uses. Essentially, "Roto-Flex" has just three main components, a fact that points up its extreme simplicity of construction, ease of incorporation into user's design, and saving in installation time. The rotating member, called the "seal nose," is an integral unit and cannot come apart. It is held by a compression spring against the fixed surface, or "stationary seal."

The operating conditions of the application for the seal, or course, determine the amount of spring pressure necessary to make sealing positive and determine materials used for the lapped wearing surfaces and other component parts. In addition to the single unit, double units (two rotating seals mounted on opposite ends of the compression spring) are also furnished see illustration; these are designed for such installations as one where the liquid being sealed cannot act as a lubricant or coolant, and a separate liquid supply is admitted into the seal chamber. Gits Bros. Mfg. Co.

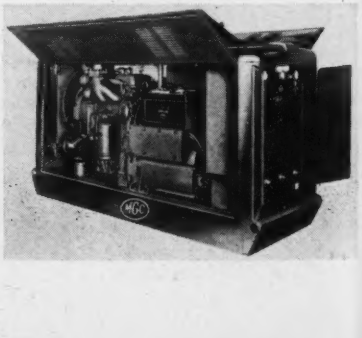


C **Condensate Return Unit.** A new "Packaged" Condensate Return Unit, the Type UA, which features simple construction and compact assembly, has been announced. Designed for use with heating systems in small office buildings, and small industrial plants, this 20 gallon unit returns condensate to the boiler at high temperatures insuring quick and steady heat and minimizing heat and fuel losses. The Type UA unit is completely automatic and includes pump, motor, receiver tank, float switch, a strainer, piping, and base in the assembly, which requires only 5 sq ft of floor space. The pump employed is the turbine type and is equipped with bronze liners and impeller to resist corrosion. Roy E. Roth Co.

D **Engine-Generators.** New MGC engine-generator sets are available in single or three phase, 50 or 60 cycle, and in sizes from 5 kw to 60 kw. Each set is self-contained and fully equipped with controls, radiator, fuel tank and weatherproof canopy.

The units are delivered factory-assembled and wired complete ready to put into service. The generators are of the revolving-field type with direct-connected exciter and built-in automatic voltage regulators which are designed to produce terminal voltage within 3 per cent at any load or power factor within the generator rating.

D-c generators are of the compound-wound interpole type and are available in any size, 5 kw through 60 kw. These generators are of the single ball bearing heavy-duty type and are directly



DECEMBER, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

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Simple pipe bend . . .
Or complex unit fabrication
It's CRANE for precise workmanship!

No job is too difficult for Crane Pipe Fabricating Shops. Strategically located . . . skillfully manned . . . Crane Shops give you the finest fabricated piping service available. For Crane completes your *entire* job—bending, stress relieving, heat treating, even radiographic examination of welds, if required—before testing each assembly as a unit.

Whether for power or processing systems, high or low pressures—Crane unit fabrication of valves, headers and other piping assemblies stands out as the finest combination of materials and workmanship. All operations are rigidly checked under laboratory supervision. Strictest adherence to specifications helps to fulfill every intent of your design. And since Crane Shops prove major assemblies in advance of installation, your piping systems are completed in the field with least effort and delay.

Crane Co., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*

ONE
SOURCE OF SUPPLY
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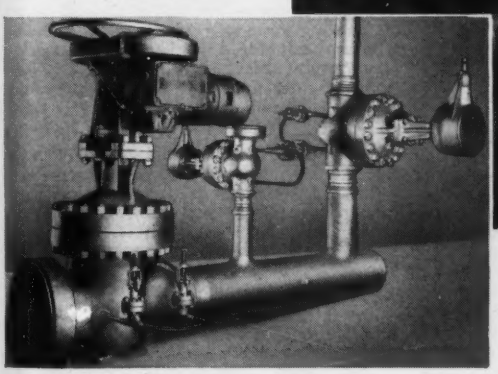
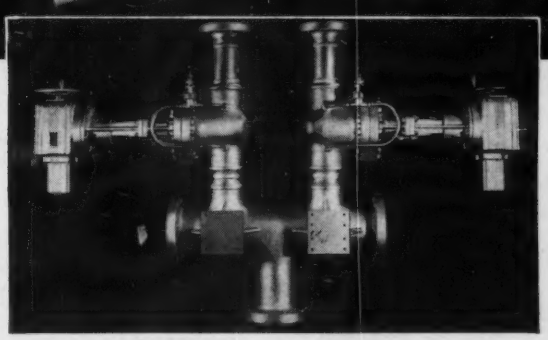
FOR BOILER FEEDWATER *service in Arkansas power station, this integrated header contains 17 welding-end valves. Fabricated by Crane and delivered as a unit.*

12 x 8 x 4-IN. HEADER ASSEMBLY *shipped as a unit to a central station. Completely fabricated, stress relieved, and tested by Crane.*





STEEL HEADER *with two Crane 8-in. motor-operated gate valves. Fabricated as a unit in Crane Chicago shop for main steam service at 850 psi and 900 deg. F.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

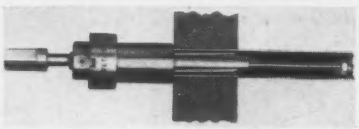
FOR EVERY PIPING SYSTEM

XUM

connected to the engine by a flanged coupling.

Both types of generators up to 25 kw are available with gasoline engine, whereas units with 20 kw through 60 kw ratings have Diesel engines. They are designed for stationary, portable or standby service. Motor Generator Corp.

E **Tube Expanders.** Two newly designed self-feeding tube expanders with ball bearing thrust are being introduced. They are known as the G-800 (illustrated) and G-1200 Tube Expanders and are for precision rolling of condenser and heat exchanger tubes of ½ in. od to 1½ in. od. They are especially effective in rolling bi-metal tubes and for use in thick tube sheets.



An outstanding feature of these expanders is the adjustable ball bearing thrust collar and mechanism which eliminates cage friction and results in smoother rolling operations and longer expander life. During operation the adjustable ball bearing thrust collar of these expanders remains stationary against the tube end and the thrust load is transmitted to the ball bearings. This minimizes frictional heating and any cutting of the tube ends. The expanders are self-feeding and parallel rolling. The fine grained, heat treated rolls are tapered to produce a uniform expansion which tightens the tube throughout the entire thickness of the tube sheet. The front of the rolls has a long, gradual radius which does away with any possible ridging. The Aire-tool Mfg. Co.

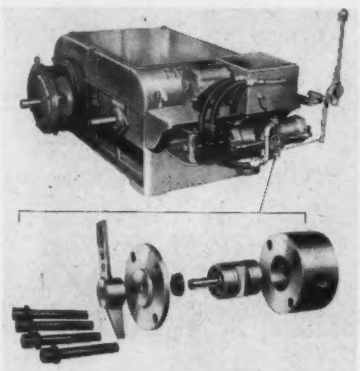
F **Small Steam Trap.** A new, small steam trap designed particularly to meet needs for smaller capacity steam traps has been announced. This trap fits standard applications wherever small drainage is a problem; it is listed as No. 070.

Available for pressures from 0 to 150 psi, this new, small trap was especially built for small drainage jobs where condensate loads are light and conditions call for the economy of an inverted bucket trap.

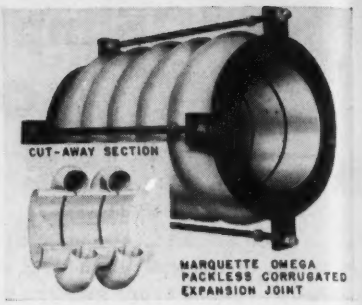
Special features include: renewable seat, easily removed for servicing; seamless deep drawn, stainless 18-8 bucket, no welds; oversized ports, increased flow capacity; wear-resistant Anum-Metl valve and seat; and Hi-Cap orifice for greater capacity.

This steam trap was subjected to rigid field tests in its development stages. Some of the manufacturer's recommended applications include laundry and dry cleaning equipment, industrial unit heaters (up to 150,000 Btu); kitchen and restaurant equipment; hospital equipment; tire recapping equipment, and other small drainage applications. Strong, Carlisle & Hammond Co.

G **Control Valve.** A new, rotary type valve to provide maximum efficiency on hydraulic controls for variable speed transmission is now available. The new valve is an exclusive feature of the company's hydraulic control which, applied to the Transmission, permits entirely automatic speed regulation for synchronization of different machines and separate sections of a single machine; maintenance of control tension and uniform peripheral winding speeds; and maintenance of uniform pressure, weight, liquid level, temperature and other variable elements. Extremely simple in design and with few moving parts to wear, the valve is actuated with only four ounces pressure. Its stem is mounted on ball bearings to assure smooth operation, with minimum friction or "drag". Because of its rotary design, eliminating lateral motion of the stem, the new valve can use to full advantage a tight-fitting, cup-type oil seal which prevents oil leakage around the valve stem. The new rotary type valve is being installed on all the manufacturer's new Variable Speed Transmissions, replacing the stem-type valve previously used. It also is available for replacement on transmissions now in service. Only two sizes of valves are required to fit all the manufacturer's transmissions using hydraulic controls. Reeves Pulley Co.



H **Expansion Joint.** Pipe line movement, axial, lateral, transverse or vibratory, is taken up uniformally by each self-equalizing corrugation of the new Omega Expansion Joint recently announced. Stresses and fatigue rate are negligible and much thinner metal can be used for a given pressure. Compression occurs under lower applied thrusts and corrugations can function only within the elastic limit for which they are designed. By incorporating a circular cross-section in the design, the possibility of distortion is eliminated. Pressure merely puts the metal under tension. Side walls of corrugations need not be depended upon to limit movement and equalizing rings are not necessary. As a result, the joints are amazingly light for any specified diameter and pressure. They are simply installed and have long life. Omega Expansion Joints are made with an id from ½ in. to 25 ft for any pressure from vacuum to 50,000 psi. Marquette Coppersmithing Co.



J **Electrical Insulation.** An entirely new type of electrical insulation has been produced. Called "Quinterra", the product is the result of eight years of study and experiment. Quinterra is a completely inorganic, asbestos-base insulation possessing properties of thinness and electrical insulating strength never before attained in a flexible, inorganic asbestos sheet. In appearance Quinterra resembles paper and is furnished in long lengths in roll or tape form. Quinterra is of closed structure, and has no holes or interstices. It is of particular interest as an electrical insulation where high temperatures are encountered since tests demonstrate that it retains its high dielectric strength of well over 250 vpm even at elevated temperatures. Manufactured by a special paper making process it can be varied from a tissue-thin 1.5 mil to 20 mils in thickness. Johns-Manville officials explained that initial manufacturing will be in thin sheet form for electrical wire insulation and slightly heavier for layer insulation. Future plans call for the manufacture of a variety of thicknesses and laminates for other electrical insulating purposes. Johns-Manville.

K **Recording Vibrometer.** A new recording vibrometer which measures and records frequency, displacement, and wave shape of mechanical vibration, has been announced. Built to operate either when mounted on a fixed base or held in the hands the vibrometer weighs only 7 lb and is less

Coal Saving gets more important all the time!

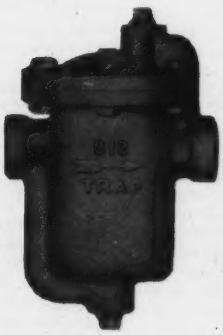
12 ARMSTRONG TRAPS SAVE 1/2 TON OF COAL PER DAY reports American Snuff Company, Clarksville, Tenn., since unit trapping coils in their tobacco drying kilns.

38.5%

FUEL SAVING

Of reports turned in over the past 18 years dealing with steam saving secured by Armstrong Trapping, those that give figures show savings of 13 to 50% with an average of 38.5%.

Left—*Bottom inlet—top outlet series. Available with cast semi-steel (250 psi maximum) or forged steel (2400 psi maximum) bodies and caps. Complete range of sizes.*



Right—*Side inlet—side outlet series. Available in four popular sizes for pressures to 250 psi.*

Armstrong Steam Traps are sold on a basis of "satisfaction or your money back." Trained factory representatives are located in 47 principal cities. Traps are stocked at 147 points.

CONSERVATION of your coal pile is vital these days when you have to read the newspaper each morning to find out how much coal costs and whether you can get any.

Armstrong Steam Traps will help you save coal (or any fuel) for the following reasons:

NO STEAM LOSS—no steam leaks past the Armstrong trap valve, even when there is no condensate load. When steam enters the trap, the bucket floats and closes the valve. Full steam pressure behind the valve holds it closed *tightly.* (The chrome steel valve and seat are hardened, ground and lapped to a precision, steam-tight fit).

NON-PRODUCTIVE RADIATION LOSS MINIMIZED—with Armstrong traps, steam gives up more heat through the steam-consuming unit, less through the supply and return lines. Removal of condensate *and air* as fast as they accumulate assures maximum heat transfer efficiency. Steam flow is faster. Condensate is discharged at steam temperature—no cooling legs, no drainage delay with radiation loss in the line to the trap. Faster heat-up, faster production.

The **ARMSTRONG STEAM TRAP BOOK** will help you select, install and maintain traps for maximum fuel savings. Write for a copy.

ARMSTRONG MACHINE WORKS
810 Maple Street • Three Rivers, Michigan

ARMSTRONG *Quality Bucket* **STEAM TRAPS**

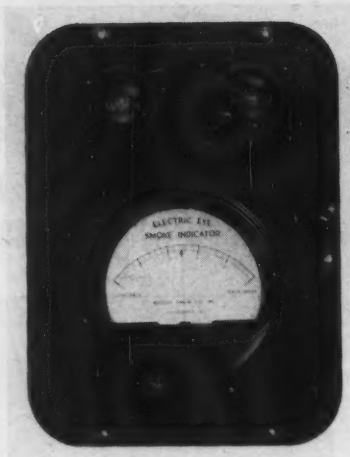
Over a Million in Use...For Power...Process...Heating

than 8 in. in length. It was developed for application in testing all types of reciprocating and rotating machinery within a vibration frequency range of 10 to 120 cycles per second. It records both steady-state and transient vibrations. A prod extending from one side of the vibrometer is set in motion when held against a vibrating body. This motion is amplified by a cross-spring arrangement and transmitted to a stylus which inklessly records the vibration on wax paper, thus making available a permanent record for vibration analysis of equipment. Another stylus produces a timing mark near the edge of the wax paper every one-third of a second. Both the chart speed and the interval between timing marks are governed by a synchronous motor operated from a 115-v, 60-cycle power supply. Two push buttons are provided to give chart speeds of 1 in. per second and 3 in. per second. Motion of the stylus on the chart can be observed through a window in the top of the all-aluminum case. One side of the case can be removed easily, for rapid replacement of the wax paper roll when its 50-ft capacity is depleted. General Electric Co.

L **New "Shorty" Jack.** A 15-t capacity "Shorty" Jack, designed for repairing cranes, and low-set loads in industry, shipyards, on construction jobs and on railroads is announced. Just 7 in. high and weighing only 22 lb, the new jack has a capacity of 5-t greater than the company's No. 1007 Jack of the same height. The "Shorty" is a ball bearing screw jack, and utilizes a

ball thrust bearing instead of a pintle bearing as used in Model 1007. This new jack housing is of one-piece malleable iron, and features machined, cut and heat-treated gears. The ram is made of seamless tubing fitted with a high-strength bronze nut and the screw is heat-treated and fitted to the gear which is supported on the ball thrust bearing. Many of the parts of this new Jack can be used inetrchangably with the No. 111-C-2 Jack. Duff-Norton Mfg. Co.

M **Over-Fire Control.** Electric eye smoke indicators have now been adapted to control over-fire air to prevent smoke in coal burning furnaces. A light beam projected across a boiler or furnace flue shines on a photo-tube which measures smoke density. When this density increases beyond a predetermined amount, a red warning light flashes and a timer relay circuit is closed. This starts the over-fire air jets. These jets remain on for the period of

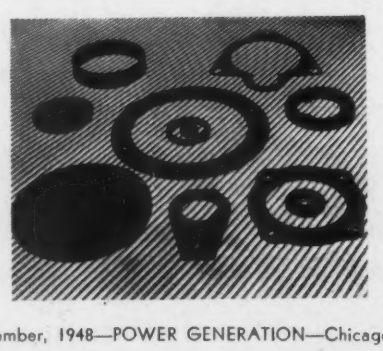


time for which the time relay circuit is set. Upon completion of the time cycle, the jets are turned off. If smoke returns the entire cycle is repeated. Manual push button operation of jets is also provided. The advantages claimed for this system are—Light source and Eye Box all aluminum construction completely dust-tight. Sealed lens and gasketed covers. Tripod support on light source for adjusting light beam direction. Built-in voltage regulator for precision indication. Brooke Engineering Co., Inc.

N **Soldering Flux.** This new liquid aluminum soldering flux makes possible sweating of aluminum, stainless steel, monel, copper, brass, steel or any combinations of these metals. This flux breaks the surface oxide on all types of aluminum so that a sweat job is possible.

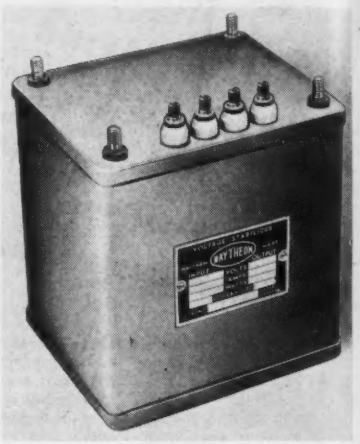
When used in combination with this company's All Metal Solder it is said to eliminate the electrolytic action between dissimilar metals so that a permanent bond, highly resistant to corrosion is obtained. Induction heaters as well as torch or iron can be used for heating mediums. This flux is $3.50 per pound. Farrelloy Company.

O **Rubber Gaskets.** A standard line of punched or extruded rubber gaskets, washers and sleeves has been announced. This new line of products has been designed to have unlimited applicational value in automotive, plumbing, electrical and other general manufacturing fields. Gaskets, washers and sleeves are available in almost any quantity in such synthetic rubbers as Buna S, Neoprene, Butoprene (Hycar and Buna N) and Thiokol; and in natural or reclaimed rubbers. Certain



compounds are available to provide rubber products with maximum resistance to acids and alkalies. Oxident additives provide rubbers with weatherproof qualities. Capable of withstanding normal temperatures of from minus 60 to 225 F, rubbers can have durometer hardness range of from 30 to 100, tensile strength of from 500 to 3500 psi, and elongations from 50 to 900 per cent. The Stalwart Rubber Co.

P **Voltage Stabilizer.** A new model has been added to this company's VR-6000 catalog and custom-engineered voltage stabilizer line. It is a hermetically-sealed, frequency-compensating model of 15 w rating, for an input frequency range of 52 to 63 cycles, input voltage of 95 to 125 v and output of 115 v stabilized to plus or minus 1 per cent for both line and frequency regulation. Oil-filled for highest cooling efficiency, this compact stabilizer has been designed for maximum resistance to shock and vibration. The case is plated be-



fore painting for greatest resistance to corrosion. Mechanical features include stainless steel mounting studs, and the hermetically-sealed terminals. Raytheon Mfg. Co.

Q **New Crane.** Production of a new 3-t capacity Hydrocrane — the Model H3—has just been announced. The new unit is designed for the economical handling of small jobs on which the use of a conventional crane excavator would prove too expensive. Simplicity is a key economy-making characteristic of the Hydrocrane. Full hydraulic operation of the crane (powered by truck engine, governor-controlled to run at the middle of its normal speed range) eliminates shafts, drums, gears, clutches, brakes, chains, and sprockets . . . is easy to maintain. All functions, including the closing action of the ⅜-yd clamshell bucket, and the 370 deg. swing, are hydraulically controlled. Operation is easy, because there is no need to synchronize hand and foot motions. Safety is promoted, because there are no clutches or brakes to slip; hydraulic control is positive and precise. Furthermore, it is stated that the nature of hydraulic operation makes the machine almost weatherproof. Lacking clutches or brakes, it operates equally well in 100-degree and sub-zero temperatures.

According to the manufacturer, the

Welded piping at Capital City Products Co., Columbus, Ohio

Hercules would have needed help

HOLDING together Dowtherm-jacketed steam lines would have been too tough for the mythical strong man of yore . . . even for a little while. But, at Capital City Products Company, Columbus, Ohio, Tube-Turn welding fittings have been doing just that—*for eleven years*!

There are good reasons why Tube-Turn welding fittings have successfully weathered eleven years of service on the piping shown above. The welded joints are permanently leakproof and form a continuous metal structure with the pipe. Forged-in strength gives them the ability to take punishment for years with little maintenance. Insulation—easy to apply—need never be removed because of joint failure. Full effective radius and smooth inner walls reduce friction and erosion, minimize pressure loss.

For the utmost in strong, dependable piping connections, remember "Tube-Turn", the No. 1 trade name in welding fittings. Your Tube Turns distributor has a large stock in a wide range of types, sizes, metals, and alloys. For good service in good connections, specify "Tube-Turn".

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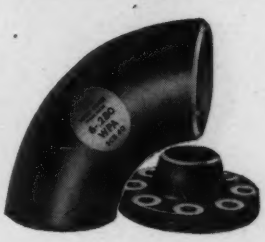
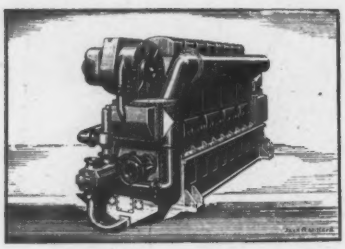
WELDING FITTINGS AND FLANGES

Write for the new and revised Tube Turns' chart of "Pipe and Fitting Materials". Covers ASTM and other specifications, chemistry, service temperature limits, welding data.



3-t Model H3 is exceptionally mobile. Supplied as a complete package, factory-mounted on a new motor truck, it can travel at fast highway speeds from one job to the next . . .set up for work in a hurry on its hydraulic outriggers. Hydrocrane Div., Bucyrus Erie Co.

Diesel Engine. A new, 9 by 12 Diesel engine, with ratings up to 1,200 hp designed for extremely high-working pressures, and described as one of the heaviest duty Diesel engines of its kind ever developed in this country. The new engine is applicable for railroad motive power, electric power generation, mechanical power take-off, and



marine propulsion and auxiliary drives. Its ratings, for eight cylinders, supercharged, at sea level, is set by the manufacturer at a maximum of 1200 hp.

A vertical, four-cycle design, the Diesel is built in six-and eight-cylinder executions, normally aspirated or supercharged. Both six- and eight- cylinder types are single acting, solid injection.

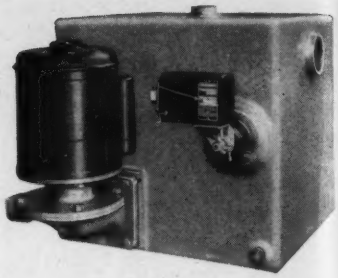
Of particular interest is the intercooling provided on all supercharged models. Lima-Hamilton Corp.

New Motors. A new line of tube-type, totally-enclosed, fan-cooled, squirrel-cage motors ranging from 150 to 600 hp has been announced. The use of tubular type heat transfer follows, in general, the methods employed in previous motors of larger size built by the company. Internally, the new motor is divided into two isolated parts with each side having its own path of internal air circulation. Because of its construction, it is possible, through simple maintenance to keep the motor free of power-destroying agents which tend to clog air passages in the conventional type of fan-cooled motors. The new line is being offered with Underwriters' labels for 1-D or 2-G locations in ratings of 3600-rpm 250 to 400-hp, 1800-rpm, 200 to 300-hp and 1200-rpm 150 to 200-hp. Initial order for these motors is for driving centrifugal pumps in various stations of a pipe line forcing oil and gasoline over 600 miles from Texas to Missouri. The new motors are expected to have wide application in many industrial installations. Allis-Chalmers Mfg. Co.

Anchor, Drill Kit. To help simplify screw anchoring problems—Sand Scott plastic expanding Screw Anchors are now available in an Assortment Kit along with 3 carbide tipped masonry drills. This new combination kit offers extreme flexibility on all anchoring jobs since the anchors are universal for mounting screws into any and all materials such as: Plaster, concrete, brick, tile, glass, sheet rock,

etc. The Holub drills are also universal for drilling all materials and especially designed for use with hard materials such as: concrete, tile, brick, marble, etc. They can be used with electric or breast drills and clean holes are drilled in 30 seconds. This unique development greatly speeds up screw anchoring installation, assures tremendous holding power, neater work and much lower cost. Holub Industries, Inc.

Small Condensation Pump. An entirely new, compact, low price condensation pump with several improved engineering features has just been developed. Known as the 4100 Series Condensation Pump, the new unit has a wide capacity range that solves the problem of stocking various sizes. It is conservatively rated to handle any capacity up to 6000 sq ft edr, against a discharge pressure up to 20 lb. The new unit is exceptionally neat and compact—free from external piping, angle iron supports, and irregular surfaces. All parts such as the motor, pump, float switch, and drain plug are easily accessible from the front for quick inspection and fast servicing. Simply by removing four cap screws, the entire motor and impeller assembly may be lifted from the pump housing without disconnecting piping. Disassembly of the unit is accomplished without prying or hammering, only two hex

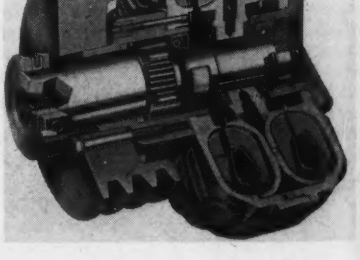


keys and an open end wrench being required.

The two-piece construction of the bronze impeller has been designed specially for this unit. Such design assures very smooth surfaces within the impeller passages to handle condensate with the greatest efficiency in relation to pump size. The impeller, in addition, is fitted with an oversize carbon type rotary seal which will give thousands of trouble free hours under normal operating conditions. Since this seal runs on the impeller hub, the motor shaft is not exposed to corrosion by condensate. There is no packing which can be over-tightened. The capacitor-start ¼ hp dual voltage motor is dynamically balanced for quiet operation, Vertical mounting above the pump, together with drip-proof enclosure, protects it from moisture. Conservative rating assures that no pressure variation can load the motor beyond its safe horsepower rating. Condensate is collected in a heavy 15-gal steel tank. A built-in strainer protects the pump from clogging. Levels are controlled with a non-corroding float set to a dependable single pole float switch. Sterling, Inc.

Hydraulic Drive. The new Hydro-Sheave Drive is a hydraulic-conversion device for small electric motors and internal combustion engines. The basis of the new unit is a small hydraulic coupling, long successful in smothering shocks and smoothing the flow of power from motors or engines in the ¾ to 25 hp range. Designed especially for use with Worthington QD (quick detachable) V-belt Sheaves, the new Hydro-Sheave Drive package consists of a small hydraulic coupling, with a sleeved shaft which slides directly over the output shaft of any small electric motor or engine.

In the drive, oil is the only medium of power transmission. Incoming power from the electric motor or internal combustion engine rotates the hydraulic



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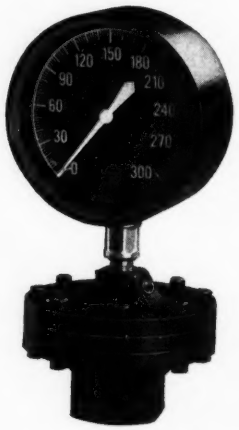
coupling inner member, the blades of which throw a continuous stream of oil against the vanes of the coupling outer member, or housing. The rotation of the housing with its attached sheave or sprocket provides a steady, uninterrupted flow of power to the driven equipment. A sudden shock, or overload, from the driven equipment is absorbed by the fluid in the hydraulic coupling and never reaches the motor or engine. Conversely, torsional vibrations from the engine or motor are effectively dampened out by the fluid and never reach the driven equipment. Twin-Disc Clutch Co.

W **Motor Crane.** A giant, rubber-tired, two-engined moto-crane, said to be the world's largest, has been announced. This latest development has a safe-rated lifting capacity, on outriggers, of 45 at a 12-ft radius. By its ability to lift and transport much heavier loads than could previously be handled by rubber-tired crane, the MC-820 Moto-Crane greatly extends the rubber-tired crane's basic advantages in heavy-duty crane service as, for example, in steel mills, steel erection, ship building, bridge building, logging, oil fields, and any other industries where the handling of heavy materials is an essential operation. Many applications are anticipated as industry gains experience with the new unit. Thew Shovel Co.

X **Valve Refacer.** A new "99" Valve Refacer, a streamlined basic model of the widely accepted Thor refacer line, designed for precision, wet grinding has been announced. The new refacer is equipped with a double-grip collet and new speed chuck for fast, precision valve refacing at all standard angles. Extra heavy construction, automatic bearing compensation at critical points of wear. Sliding heads feature smooth-riding three-point suspension on hardened and ground slide rods. Double-grip collet is hardened, ground and internally lapped, gear driven by its own individual motor. New speed chuck permits even large butt-end valves to be admitted and released with only one turn of the new 2¼ in. hand wheel. Independent Pneumatic Tool Co.

Y **Air Compressor.** A vertical air compressor that is outstanding for the floor space it saves the user has been announced. The space saving feature has been developed by designing the unit with the tank upright and the motor and air compressor unit mounted on top. Three models have been developed. They are: The model 25-v, which has a twenty gallon tank with a 1½ cu ft per minute air displacement; the model 50-v which has a 30 gal tank and displaces 2.7 cu ft of air per minute; and the model 75-v with a thirty gallon tank that displaces 4.07 cu ft of air per minute. The model 25-v requires only 20 in. diameter of floor space and the other two models require only 24 in. diameter. All three units are equipped with a single phase motor that operates on either 110 or 220 v. The model 25-v has a ¼ hp motor, the 50-v a ½ hp motor, and the 75-v a ¾ hp motor. These compressors are made from high quality steel with electric welded construction. They have withstood a 400 lb hydrastatic test and have a 200 lb working pressure. Each is equipped with an automatic pop valve and adjustable automatic switch. Grimes Co.

Z **Chemical Gage.** A new chemical gage particularly suitable for chemicals and other viscous liquids which either corrode or clog the Bourdon tube of a standard pressure gage, has been announced. One feature of this new chemical gage is that the diaphragm is made of Teflon which satisfactorily resists practically all corrosive chemicals. The use of a Teflon diaphragm instead of metal makes it possible to supply this gage for vacuum and for compound ranges as well as for pressures as high as 1600 psi and for temperatures at the gage of 300 F. The removable bottom part and diaphragm ring are supplied in cast iron, bronze, steel, stainless steel, hastelloy, lead coated iron, and Monel. Helicoid Gage Div., American Chain & Cable Co., Inc.



AA **Flow Transmitter.** A new pneumatic flow transmitter which will be on exhibit and in operation at the forthcoming 18th National Power Show in New York. This new flow transmitter extracts the square root of output pressure thereby producing a transmitted pressure directly proportional to flow. Republic Flow Meters Co.

BB **Hydraulic Gage.** A new hydraulic dial gage known as "Hydrodial"—employing an ingenious adaption of the direct action principle of its standard gages has been announced. Use of the direct action principle in the gage permits a rugged type of construction eliminating delicate parts and is capable of withstanding surging and pounding hydraulic pressures. The new gage is made in 9 pressure ranges, the lowest of which is 5-50 lb and the maximum 500-5000 lb. Dial face is white, numerals black and crystal, a shatter-proof plastic. The large, clear calibrations can be read at a distance of 50 ft. A. Schrader's Sons Div., Scoville Mfg. Co.

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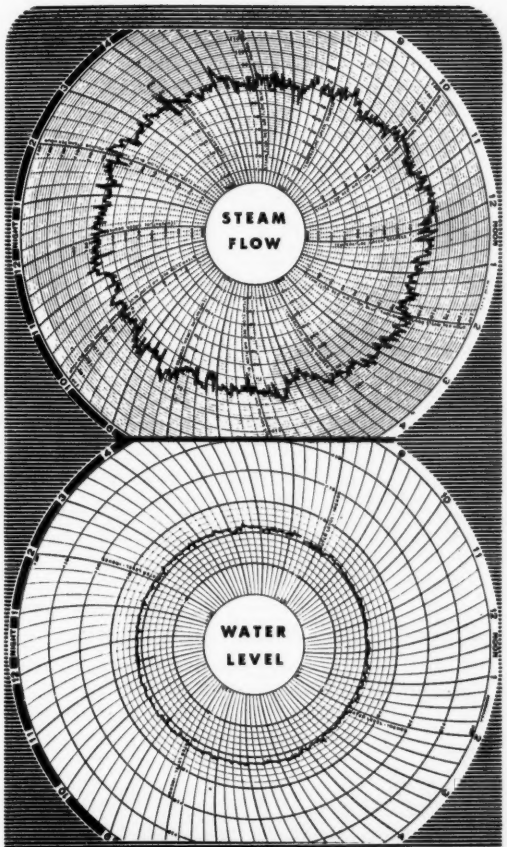

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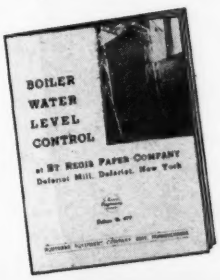

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BOILER WATER LEVELS *at* EYE LEVEL

Boiler water level readings are brought right down to eye level—on the instrument panel or any other place in the power plant—with the Yarway Remote Liquid Level Indicator.

Indication is *instant* and *accurate* because indicator is operated by the boiler water itself. Mechanism is never under pressure. There are no stuffing boxes—operation is frictionless. Complete separation of indicating and actuating parts is obtained by permanent magnet transmission.

Yarway Remote Indicators are used not only for boiler water level readings, but also for other liquid levels.

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NEW CONTROL UNIT PROVIDES REMOTE SIGNALLING

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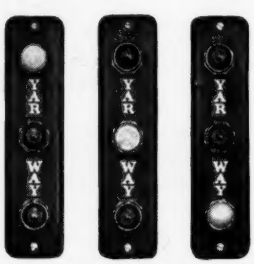

Light alarms

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WHAT LEADERS SAY

Will Tomorrow's Executives Be Engineers?

By WALTER EVANS

CIVILIZATION has advanced, down through the years, because men have "made things". And, by and large, the chief makers-of-things have been those mechanically - endowed individuals we have come to know as engineers.

Thanks to them we understand the wheel and the lever . . . we generate and use steam and electricity . . . we exchange intelligence by the printed word or by telephone, telegraph, or radio . . . we fly from coast to coast in a matter of hours . . . we have vaccines and vitamins to keep us healthy . . . and we use wood, paper—even coal—in the clothing which keeps us warm.

Each of these wonders, today's engineer takes in his stride. His ingenuity forms the broad base on which the high standard of living in America is based. This modern engineering development in partnership with modern business methods will continue to make the United States the focal point of progress.

The coming of mass production was a real tonic for the engineering profession.

Prior to this time engineers had been going quietly about their work for years. They were recognized as necessary adjuncts to business, but when their designing and testing were completed they usually retired to their laboratories to begin new experiments while administrators, trained in other fields, took over active management.

These top-level executives usually came from two professions—they were bankers or lawyers. Few came from the ranks of engineers because of the dearth of engineers with the broad interest and experience required.

With mass production the engineer came into his own. As industry became more complex, the engineer who understood what was happening joined the lawyers and bankers in administrative positions, because industry had new problems which only the engineer could solve.

To most engineers this was a difficult and distasteful task because they were unprepared by training—and usually by temperament as well—for this dealing *with* people rather than *with things*.

Despite these handicaps, during the last decade engineers have begun crowding the bankers and lawyers in this contest for high-level administrative posts. So successful have been their efforts that an independent survey published within the last year shows that 1/3 of the largest corporations in America—50 out of 150— are headed by graduate engineers. This figure becomes even more significant when one recalls that there are 10 liberal arts and teachers colleges in the country for every engineering school.

I think it might be well to digress for a moment to see just where engineers wind up in our economic life. Generally, they follow one of three courses:

First are those who devote their lives to teaching, research, or advance development. Second, those who choose active careers as engineers in industry with the opportunity to move on to management posts. And third, those who never use their engineering education as such, but find it of greatest worth in achieving important positions in other fields.

Each of these categories makes an important contribution to our way of life, and it would be a brave man, indeed, who would undertake to say which contribution is greatest.

Our concern, however, centers about the second and third groups from which our distinguished list of present-day business leaders comes. What specific characteristics enable certain men to move on to high management positions?

Five special attributes appear to mark these successful individuals; An ability to express themselves clearly and well; normal curiosity regarding economics, finance, law, psychology, and other non-engineering subjects; a willingness to make the logical and reasonable compromise with perfection which day-to-day business requires; a ready understanding that income must exceed outlay; and above all, an ability to get along with their contemporaries and at least to understand their competitors.

Each of the foregoing characteristics is essential to management success, but there is another without which all the rest are lost. This magic key to successful administration is ability to get along with people. This ability to cooperate with one's contemporaries influences every human relationship and is responsible more than anything else for the success or failure of a business executive.

I firmly believe that the engineer is tomorrow's executive—if he wants the job and if we, as today's engineers, lend our support.

We know that some engineers make good administrators. The problem, to me, seems to be why aren't there more engineers in executive posts, and what can we do about it?

An engineer's training—an orderly scientific approach to a given problem—gives the engineer a sound foundation for management responsibilities. If he adds the special attributes mentioned earlier, he becomes

(Continued on page 128)

Walter Evans is vice president of Westinghouse Electric Corp. and vice president and general manager of Westinghouse Radio Stations, Inc. The above is a condensation of a paper he delivered at the Johns Hopkins University recently before Tau Beta Pi, honorary engineering fraternity.

Mr. Evans was born in Columbus, Ohio in 1898, studied electrical engineering at the University of Illinois, served in the Navy in World War I, returned to the University of Illinois and later attended the University of Chicago. Interested in radio from boyhood, like so many of his generation, Mr. Evans became a ship's radio operator on the Great Lakes at 17, was an instructor and 1st class operator in World War I, then worked as ship's operator for Marconi Co., RCA, United Fruit Co., and others.

He joined Westinghouse in 1921 as a radio operator at the then new Station KYW in Chicago and has been prominently identified with all Westinghouse company radio activities since that time. He rose rapidly through ranks of station chief engineer and technical superintendent for all stations; and in 1933 was made manager of the Radio Division in charge of all manufacturing as well as broadcasting. He has been a vice president of the subsidiary since 1939 and of the parent company since 1942. He is a member of IRE, Army Ordnance Association, ASNE, and other technical and social organizations.

New Pulverized Anthracite Unit At Scranton's Suburban Plant*

First pulverized Anthracite plant to operate at 1000 F placed in operation in April of this year has many new and unusual features

By **L. B. SCHUELER,**
Assistant Mechanical Engineer, American Gas & Electric Service Corporation

and

A. R. WEISMANTLE,
Assistant Manager, Steam Division, Foster Wheeler Corporation

THE NEW 30,000 kw, 1350 psi, 1000 F steam electric generating unit, recently (April 1948) brought into operation at Suburban Plant by The Scranton Electric Co., is of especial interest insofar as fuel considerations are concerned. It is the first anthracite coal-fired unit designed and constructed under the complete auspices of The American Gas and Electric Service Corp., and the first pulverized anthracite fired unit to be installed in The Scranton Co. system.

The present unit represents a further step in the field of design of power generating equipment. The general cycle, in most respects, parallels that of a very similar unit recently installed and in successful operation for almost two years. The features of this cycle are described at length elsewhere[1], and will not be dwelt upon further here. Rather, we shall devote this presentation to a more specific review of the many features embodied in the design of the Suburban steam generating unit and its accessories, all of which are so firmly associated with the fuel characteristics involved. A general cross-sectional view of the plant is shown in Fig 1. This illustrates a rather conventional arrangement of equipment which was influenced, in some respects, by its relation to the existing plant and by the space available for the present and a possible future unit. Of interest is the single central control station which is designed to collect all basic controls and remote operative devices for the boilers, turbo-generator, pumps, heat cycle and electrical switching into a separate room, all in the interest of concentrated individual responsibility for most effective operation of the entire unit. Not indicated, but a part of this new unit, is a large, modern 12-cell, forced draft cooling tower which serves the condenser cooling water system in the absence of the more conventional stream or pond cooling.

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The decision to install this new element of capacity at the Suburban Plant in the City of Scranton, was necessarily followed by a thorough-going study of fuel economics, and carried along with this was the important problem of boiler design selection. The relative advantages of different types of fuel and fuel firing, in areas adjacent to the anthracite coal producing region, have been ably and extensively dwelt on by others, particularly by Frick[2] and Frisch[3]. Because of its location in the immediate zone of extensive anthracite production, no serious consideration was given to the use of bituminous coal for the new Suburban unit except that provisions for its limited emergency use are included, as described later.

The natural decision to burn anthracite still left several alternatives to be given serious consideration. These involved the question as to whether the boilers should be (a) stoker fired, utilizing a mixture of No. 3 and No. 4 buckwheat, or (b) pulverized coal fired, utilizing No. 5 buckwheat and anthracite refuse. In considering pulverized coal firing, it was necessary to decide between the unit and storage system arrangements, and determine whether external drying or mill drying should be used with either system.

Comparison of stoker firing vs. direct pulverized firing favored the latter since two boilers were necessary with stoker firing because of grate size limitations, while pulverized firing could be readily accomplished with a single boiler. The two-boiler arrangement suffered from considerably greater space penalty, somewhat higher boiler cost, and considerably higher auxiliary equipment and piping cost. The single boiler setup was not considered objectionable, in view of the high availability attained with similar equipment, and the size of the unit was not too large as to weigh heavily in the total available capacity of the interconnected network into which the Scranton system is tied. Furthermore, the important matter of relative fuel cost was decidedly in favor of pulverized coal firing. A fuel cost comparison, at the time the unit was projected, showed the cost of stoker size coal to be approximately $0.75 per ton higher than the fresh-mined No. 5 buckwheat available and suitable for pulverized firing, based an on equivalent heating value for both. The current cost comparison of these two fuels shows stoker sizes to be approximately $1.00 per ton higher than the other product. Still greater potential direct savings are possible in the recovery of refuse in the district, and this source will undoubtedly be developed to augment the fresh-mined product. On the basis of an estimated 125,000 tons annual coal consumption, the projected savings of a pulverized unit over a stoker unit are seen to be very substantial.

Since pulverized coal firing was determined to be the most advantageous for Suburban, a thorough study of the possibilities of both the the unit and storage system followed. A study was made of the relative proportions and quality of prepared No. 5 buckwheat and anthracite refuse available now and in the future, and consideration was given to the space conditions existing at Suburban Station. A review of modern installations and equipment available showed that the Foster Wheeler separating type anthracite burner and horizontal ball mill had reached a state of development permitting mill drying and the direct firing of pulverized anthracite with practically all the advantages expected for the storage system.

Upon consideration of these factors, it was apparent that the unit system offered the advantages of initial savings in the cost of the preparation and delivery equipment, reduced space requirements and economy in fuel and expense by elimination of pre-drying equipment.

The following description of the

significant features in the various components making up the plant coal preparation and steam generating facilities is intended to highlight features which are more particularly adapted for anthracite coal firing, and are, therefore, more or less unusual when considered in terms of more common bituminous coal applications.

Coal Handling

The coal handling system provides for direct delivery, by rail or truck, to a completely new system of unloading and transport facilities which serve the new unit as well as the existing plant. This consists principally of a track hopper which is supplemented by oil-fired thawing pits along the track and a Robins car shake-out, both specifically included to facilitate unloading of heavily frozen cars of wet anthracite fines. From the track hopper, coal can be transported by conveyor belts directly to the plant bunkers or stacked out for storage and subsequent recovery.

The coal bunker for the new unit is unusual in that it is divided into three sections by separating plates extending the full length. The two outer pockets are large and intended to carry either a prepared mine product or a refuse product. By means of two feeders serving each pulverizer, it is thus possible to use one or two types of anthracite, in varying proportions, as necessary, to permit most effective utilization of all available grades of anthracite. The small center pocket is reserved for storing a small amount of bituminous coal to be used, as necessary, for stabilizing ignition of anthracite during starting or on much reduced load periods. This bituminous feed enters the main anthracite coal stream just ahead of the feeders, all as indicated in Fig. 2.

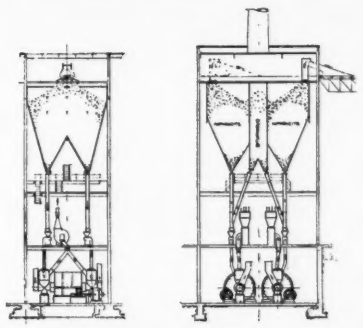

Fig. 2. Details of coal bunkers and feed to mills

Two Foster Wheeler horizontal type ball mills, as shown in Fig. 3, are used to pulverize the coal for the boiler. Experience has proved that only the horizontal, slow speed type of ball mill is sufficiently dependable and economical to operate for the preparation of anthracite.

The best degree of pulverization, or fineness, for anthracite coal has been variously estimated at from 77 to over 90 per cent through 200 mesh. Experience with the equipment now under discussion indicates that a fineness of 85 per cent through 200 mesh is most advantageous, considering cost of pulverization, losses from incomplete combustion, and from the standpoint of ignition, so this is the fineness on which the design was based. The selection of two pulverizers is usual and logical for a unit of this size. A single pulverizer was out of the question because of available size limitations and, if one were available, its operating range might interfere with the desired unit operating range. The greater flexibility of a two pulverizer arrangement was considered entirely adequate for all normal operating conditions anticipated and capable of attainment by the other equipment. Selection of three, or more, pulverizers would have been an unwarranted additional expense in view of the slight advantages of greater flexibility and availability.

The Burning of Pulverized Anthracite

The amount of air required for mill drying and best pulverization of anthracite is greater than that required to obtain stable ignition at the burner. Foster Wheeler designed a separating type anthracite burner in the early 1930's, for this purpose, its development resulting in the modern anthracite burner as shown in Fig. 4. This arrangement provides the means to divert and control, from the coal nozzles, amounts of air in excess of requirements for stable ignition.

The mixture of coal and air enters the cyclone shaped burner through a tangential inlet. This subjects the mixture to a whirling action, causing most of the coal to separate out against the sides of the burner and travel spirally downward to the coal discharge nozzles and thence to the

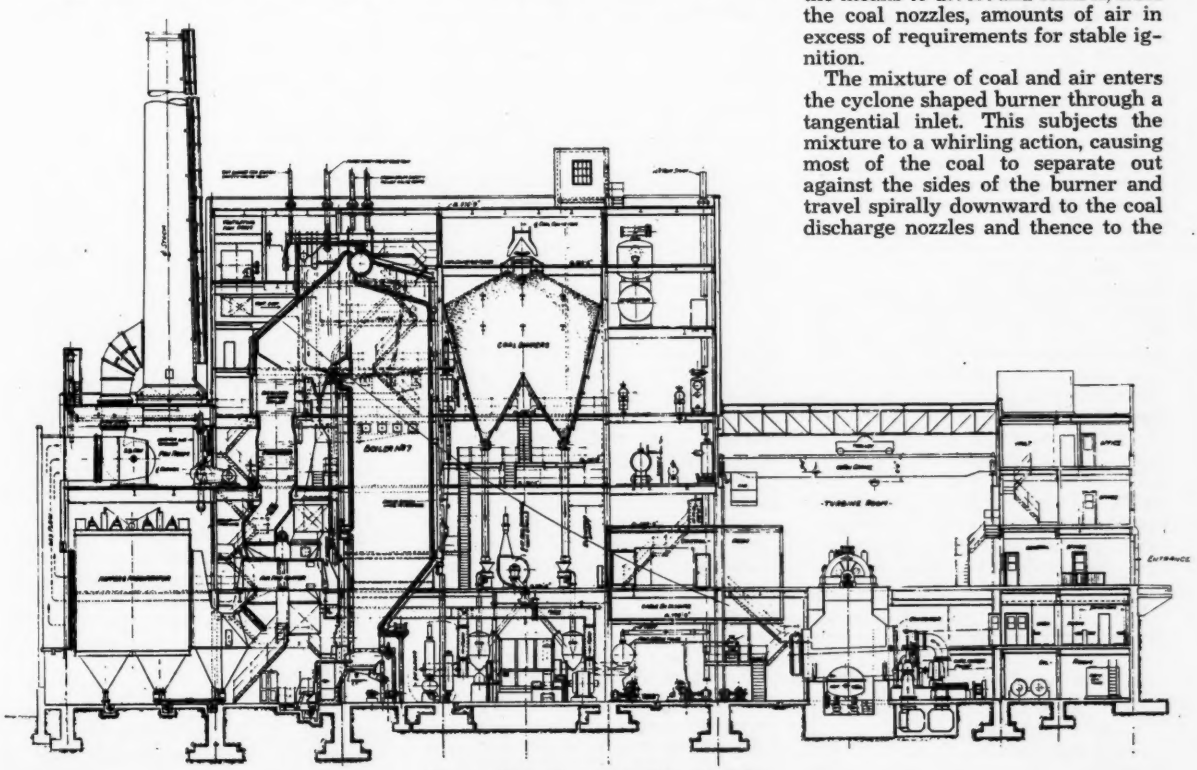

Fig. 1. General cross section of station

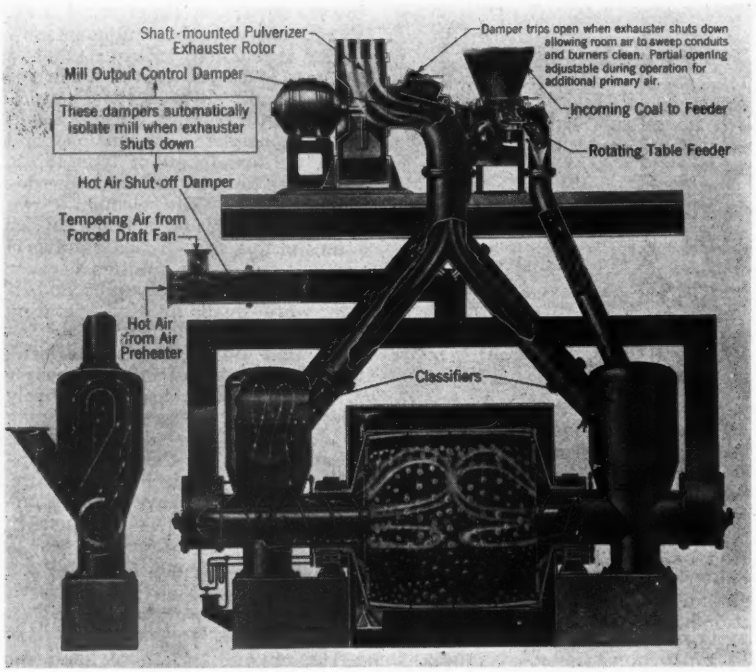
Shaft-mounted Pulverizer Exhauster Rotor
Mill Output Control Damper
These dampers automatically isolate mill when exhauster shuts down
Hot Air Shut-off Damper
Tempering Air from Forced Draft Fan
Hot Air from Air Preheater
Damper trips open when exhauster shuts down allowing room air to sweep conduits and burners clean. Partial opening adjustable during operation for additional primary air.
Incoming Coal to Feeder
Rotating Table Feeder
Classifiers

Fig. 3. Two Foster Wheeler horizontal type ball mills pulverize the coal

furnace. The air which is separating from the coal in the burner has two means of escape, one through the coal nozzles at the bottom, and another through the central vent at the top which directs it to the vent nozzles. The vent nozzles are dampered so that the nozzle resistance is controllable, and, therefore, the amount of air vented by the burner is also controllable.

Carbon Recovery

Information of basic importance was obtained during early investigations. This concerned the combustible content of particles falling to the furnace floor and the relation between carbon content, size of particle and relative carbon distribution in the fly-ash leaving the furnace. The study of particles falling and retained on the furnace floors of the various units showed an almost complete absence of combustible content, indicating that even though these particles were large and received oxygen by the slow process of diffusion, they burned out when permitted to stay in the furnace long enough. The study of fly-ash leaving the furnace showed that the larger particles contained greater percentages of combustible than smaller ones and that much of the carbon was contained in a relatively small portion of the total fly-ash. A typical analysis of such fly-ash from one installation, showing size consist and the corresponding per cent combustible, is shown in the accompanying tabulation. It can be seen that almost one-half of the combustible is contained in about one-quarter of the weight of fly-ash, this portion consisting of the larger sized particles.

A few years ago, this information led to the application of the principle of "re-burning" to pulverized anthracite units. In "re-burning," the fly-ash is trapped in hoppers on the unit and in a collector after the unit, then returned to the furnace for further burning. Results obtained with "re-burning" minimize the effect on the combustion process of the various factors mentioned previously. This is clearly illustrated by results of a set of tests conducted on one unit during which operating procedures were established haphazardly and runs were made with and without fly-ash being returned and reburned on the furnace floor. Consistent improvement in efficiencies averaging 11 per cent at design load were obtained when the fly-ash was re-burned. On this same unit good results are obtained when "best settings" of all factors are employed without fly-ash return, but under the same conditions of operation the return and re-burning of fly-ash improves efficiencies by almost 5 per cent. The methods previously used to return and re-burn the fly-ash, however, permitted a high amount of recirculation of dust through the unit.

Typical Fly Ash Analysis

Size Consist	Per cent By Weight	Per cent Combustible	Carbon, per cent of Total
+100 Mesh	1.2	68.0	2.2
—100 +200 Mesh	10.0	64.65	17.2
—200 +325 Mesh	15.2	64.35	26.0
—325	73.6	28.2	54.6

The accumulated experience gained on previous anthracite units led to the development of several advanced features applicable to the burning of pulverized anthracite, which, based on considered engineering judgment, gave promise of results better than ever previously attainable. It was, naturally, desired that the Suburban unit be the most advanced and best design which could possibly be made, so it was decided to include such features, for the first time, in the Suburban unit design. The Suburban unit design is shown on Fig. 6.

One of the important design advances included in the Suburban unit was the application of opposed vertical firing, used for the first time with pulverized anthracite. This was desirable in order to limit the heat release per foot of burner width to a reasonable value of approximately 10 million Btu per hour, which allows the use of low secondary air admission velocities, 22 ft per sec maximum, thus making for more effective use of the available furnace volume. Opposed firing also offers the important advantages of (a) eliminating the effect of flame travel up the relatively cold rear wall, which many designers and users believe to be one of the basic factors contributing to high carbon loss, (b) providing for mixing and turbulence in the later stages of the combustion process, after the flames have turned upward, and where these factors are most effective, and (c) less likelihood of heavy clinker formation since the zone of maximum temperature is confined to the two merging flame paths in the center of the furnace.

Another major design advance incorporated in Suburban was the use of the largest furnace volume for its capacity, resulting in a heat release rate of 12,000 Btu per cu ft per hr, which is lower than ever used previously with a pulverized anthracite unit. The time that a particle spends in the furnace is most important in completing the combustion process. This residence time varies inversely as the heat release rate per cubic foot, and considering that heat release rates per cubic foot on previous anthracite units were from 15,000 to 21,000, it can be seen that the residence time in the Suburban furnace is from 30 to 70 per cent longer than for anthracite units previously in-

stalled. It is expected that this will permit operation with excess air lower than has previously been found necessary.

Still another major advance in anthracite unit design, first used at Suburban, concerned the method of fly-ash return and re-burning. The return systems on previous units have been of the pressure type. The return lines terminated in cyclones for separating the dust from the carrier air, the dust being discharged to the furnace floor and the carrier air vented higher in the furnace. Cyclone separating efficiencies were low so that large amounts of fly-ash did not reach the floor but were recirculated through the unit. Suburban's return system is of the vacuum type, the fly-ash being taken from the first section of the Koppers-Elex precipitator and conveyed through a National Conveyors Company pneumatic transport system to high efficiency collection units, consisting of primary and secondary elements dis-

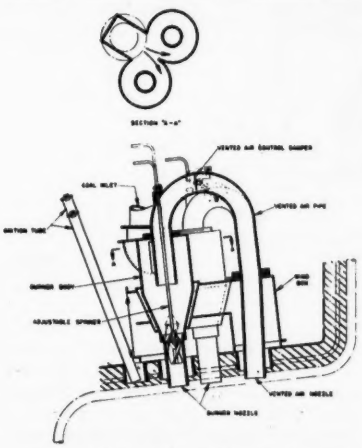

Fig. 4. Details of the Anthracite burners

charging to a common receiver, where all the air is removed from the fly-ash. The receiver discharges the fly-ash to a riffle type distributor from which it passes through four feed pipes and nozzles to the hopper bottom of the furnace. The removal of all air from the dust and its admission by gravity to a quiescent zone of the furnace greatly reduces the tendency for entrainment and recirculation.

On previous units the fly-ash was settled in piles on flat floors or between ash removal crickets, with the reduction in carbon content being haphazard, in a sense, because no special provisions were made to bring oxygen in contact with the hot carbon particles. At Suburban the returned fly-ash is held in a bed or pool in the hopper bottom of the furnace. The hopper slope and the furnace crickets are arranged for admission of high pressure air under control at all elevations, so that the bed of fly-ash may be visualized as being maintained on a "grate." Details of the design of "grate" at water-cooled sections and Detrick tile portions of the hopper slope are shown in Fig. 5. In operation, fly-ash is delivered to the bed surface, where it receives heat by radiation from the flames. Air in amounts up to 2 pounds per pound of fly-ash is admitted through the "grate" where it aerates the bed causing a circulation of particles therein and providing oxygen for reaction with the carbon in the fly-ash, an exothermic process. Water sprays are provided above the bed for the purpose of limiting bed temperatures, and water so admitted will also react with the carbon in the fly-ash, although this process will be endothermic. The air admitted below the bed is insufficient for completing the oxidation of the carbon therein, the reaction in the bed being primarily one of gasification, with the combustion process being carried to completion above the bed. The ash is discharged from the bed at the bottom, Westinghouse clinker grinders being provided to break up any chunks formed in the bed or falling from furnace walls, and Jeffrey vibrating feeders being employed to feed the refuse to the ash removal system hoppers, as necessary to maintain the desired fly-ash bed level limits.

Steam Generating Unit

In operation, coal from the bunkers is delivered by feeders to the pulverizers. Pulverized coal is taken from the mills by exhausters which deliver it to burners situated in arches located in each side wall of the furnace. The flames leaving the burners travel downward from the arches to the bottom part of the furnace and then turn in a U shaped path, join, and travel upward between the arches to the furnace outlet. The gases leave the furnace through a wide spaced screen, and make a single pass across and down through all convection surfaces, leaving through a bottom outlet connection to the fly-ash collector and fan for discharge to the stack. This single pass design was chosen to attain complete elimination of baffles and avoid troublesome maintenance.

The side walls contain the air admission ports formed by special Detrick tile shapes which cover and are cooled by 3 in. tubes paired on 14 in. centers.

This furnace arrangement and disposition of cooled surfaces below the arch was made with a view of keeping refractory maintenance within reason, while at the same time limiting the amount of cooling to values which would not be detrimental to the combustion process.

Above the arch, the front wall, roof and side walls are cooled by 3 in. tubes on 7 in. centers. The rear wall is cooled by the upper part of the radiant superheater, and above this, the slag screen, consisting of two rows of generating tubes on 14 in. centers and a third row on 7 in. centers. In this design the complete elimination of intermediate waterwall headers was planned in order to provide for maximum circulation.

Full load gas velocities throughout the unit are limited to values consistent with freedom from slagging in the high temperature regions and elimination of erosion in the lower temperature regions of the unit.

The boiler and economizer sections are protected by cast iron gilled ring surfaces but even so relatively low velocities, averaging 57 ft per sec through the boiler section and 63 feet per second through the economizer section, have been used in order to avoid wear from the highly abrasive ash. The gases entering the economizer are at 1017 F and they leave the economizer at 738 F. While it is expected that the fly-ash will erode rather than adhere to the extended surfaces of the boiler and economizer sections, it was considered desirable to arrange for washing of these surfaces. Accordingly, a removable panel was located in the offset section of the gas duct between economizer and air heater so that provisions for collecting and disposing of the wash water can be quickly installed if ever needed.

Low gas velocities on the order of 30 ft per sec are used through the Ljungstrom type air preheater which cools the gases from 738 F to 305 F. With this exit gas temperature at the full load of 310,000 lb steam per hr, it is expected that the unit will operate at an efficiency of 85.23 per cent.

Air heated from room temperature to 658 F in the air heater is directed through ducts to the air admission ports in the side walls and to the burner boxes on the arch. Provisions are made to control the amount of air admitted either through the arch or through the side wall ports.

One of the outstanding features of the Suburban Unit is the radiant-convection superheater designed for 1000 F steam temperature over a

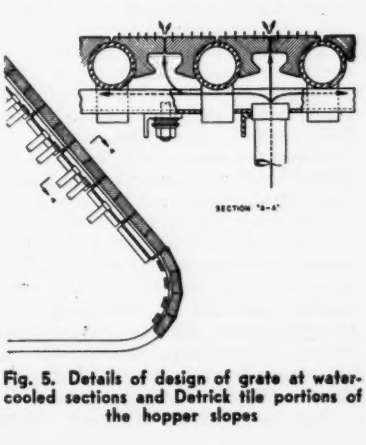

Fig. 5. Details of design of grate at water-cooled sections and Detrick tile portions of the hopper slopes

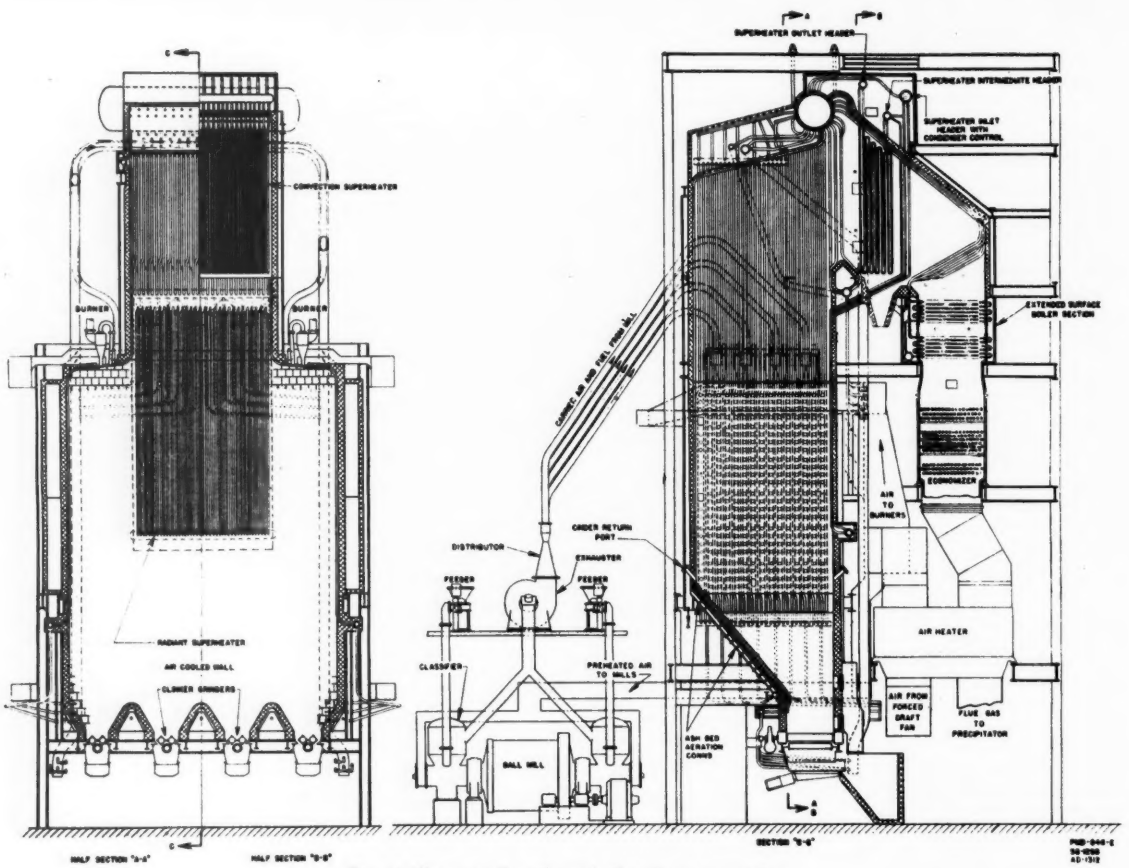

Fig. 6. Cross section through the steam generator

load range extending from 180,000 to 310,000 lb steam per hr. Inasmuch at The American Gas and Electric Service Corporation projected the first steam-electric station to use 1000 F[1] at a pressure of 1350 psi, it appears only natural that the first 1000 F unit fired by pulverized anthracite should be developed under the auspices of this same engineering group.

The combination superheater is arranged so that the steam passes first through the radiant section in the rear wall of the furnace, from which it enters the rear of the pendant convection section and flows countercurrent to the gas stream to the outlet header. The radiant superheater inlet header contains a condenser type heat exchanger for final steam temperature control.

Steam temperature control is simplified and the superheater size is kept within reason by the use of the combination superheater which, as is now well known, has inherent compensating characteristics. The disposition of the radiant and convection surfaces in the design for this job is such that the uncontrolled steam temperature at 310,000 lb steam per hour is only 23 F higher than at 180,000 lb steam per hour.

Positive control of final steam temperature is accomplished by passing a portion of the feedwater through the two tube bundles, arranged in parallel, in the radiant section inlet header. This condenses some of the steam passing to the radiant superheater, and this must first be re-evaporated before superheating can be accomplished. By varying the amount of boiler feedwater passing through the tube bundles, the amount of condensate requiring evaporation, and thus the resulting final steam temperature. is controlled. This method avoids contamination of the steam, and requires control of anly a small water flow rates to acheive the desired result. The water flow through the condenser is varied by a 2 inch motorized regulating valve.

Drum Internals

The functions of separation of steam from the circulating water and the drying or purification of the separated steam are both performed within the single 54 in. diameter drum of the Suburban Unit. Chevron type internals, arranged as shown in Fig. 7, are provided within the drum to perform these functions, and to deliver steam containing less than 1 ppm of impurity.

The decision of the Engineers that the steam generating unit must be of baffleless design, to minimize maintenance and reduce fly-ash erosion, precluded the use of any conventional boiler bank arrangement. With the general acceptance of chemical cleaning sometime ago, Foster Wheeler has developed a continuous loop extended surface type boiler section which was applicable to the baffleless, single pass design of unit, and this type of surface is employed for the boiler section of the Suburban Unit.

Dust Collection

Two considerations, (1) the location of the unit in the immediate vicinity of a large residential zone and (2) the firing method involving finely pulverized coal, left little or no room for compromise in the matter of need for effective fly-ash recovery from the flue gases prior to their discharge from the stack. The extremely fine pulverization necessary for proper ignition and combustion also results in a finer fly-ash constituent and indicates that recovery by ordinary mechanical type collectors probably would not be adequate. A rather thorough investigation of combined mechanical and electrostatic collectors in series was made, and while high efficiency was

indicated, all the disadvantages of both were also incurred, that is, high draft loss in the mechanical collector and high cost in the electrostatic collector. The final selection of an electrostatic precipitator alone was made on the basis of its overall advantages in the way of (1) extremely low draft loss, (2) reasonable first cost, and (3) extremely high collection efficiency. The low draft loss contributes in the overall effort at reducing induced draft fan suction and thereby contributing to its low operating and maintenance cost, and particularly to its higher availability, an important consideration in pulverized anthracite fired units.

The selection of the Koppers-Elex electrostatic precipitator marks the first such unit furnished in this country. The Elex design principles and engineering are represented in this unit and have a very wide background of experience and development abroad. The unit is designed to give 97 per cent collection efficiency under normal full load conditions and this excellent performance is reasonably expected in view of the very low design gas velocity and long precipitation path provided. Several views of the precipitation unit are shown in Fig. 8 which indicates the very generous proportions selected to provide for virtually complete removal of all particles of ash. The hoppers under the settling chamber directly ahead of the unit and under the first section of the unit have facilities for return of the cinders to the furnace for re-burning, as previously described, or for transport to the outside ash disposal system. This follows the normal trend of selective separation wherein the coarse, high carbon product is collected first, while the finer, low carbon product is last to be caught and this is disposed of directly, it being unsuited for re-burning. The hopper outlets serving the fly-ash return system are all provided with feeder valves to maintain a continuous positive seal on the return system and feed fly-ash into it at a continuous, controlled rate.

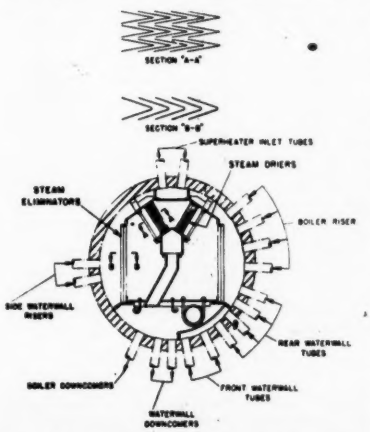

Fig. 7. Section showing boiler drum "internals"

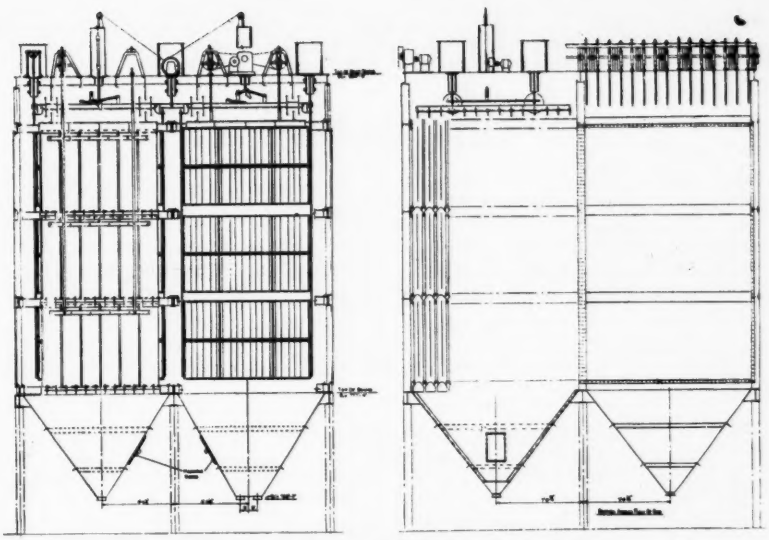

Fig. 8. Details of the Koppers-Elex electrostatic precipitators

Ash Handling

Two considerations governed the selection of type of ash handling equipment. The first was the relatively high cost of City water required in quantity for a sluicing system to an outside settling basin. The second was the known difficulty of getting fly-ash fines from the precipitator to settle in a reasonable time in a settling basin so that it could be reclaimed for final disposal and the water re-used for sluicing. The large fly-ash quantities involved, possibly as much as two tons per hour, led to the selection of a pneumatic system which could handle this product effectively and also take care of the hopper ash in good fashion. This system is designed to handle ash from both sources through a common vacuum piping system and deliver it to an outdoor bin from which it is fed into railroad cars or trucks, after suitable wetting in the feeder, for removal from the plant site to a suitable disposal point with a minimum amount of labor.

The United Conveyor Corp. pneumatic ash handling system consists of a positive diplacement vacuum pump of proper capacity to develop adequate air velocity to transport ash in the piping system. The ash is transported from the points of collection to a cyclonic vacuum discharge chamber directly above the storage bin and dumped periodically by means of a controlled sequencing shutoff and vacuum breaker. The transport air passes on through a second cyclone dust remover and a washer, back to the vacuum pump and thence through a silencer to an outdoor discharge. Normal ash removal is from the four outlets of the boiler ash hopper and the two rear section bins of the precipitator. Provision is included for ash disposal from the two settling chamber bins and the two front section precipitator bins whenever the cinder reburning system is not being operated. Each point of delivery of ash to the conveying system is equipped with an automatic device to provide for feeding into the system at a proper rate.

Controls

A fairly complete quota of controls, both fully automatic and remote manual types, have been provided for the entire unit. Also provided is a very complete set of instruments of all types, used for the most effective portrayal of operating conditions. Most of the controls and instruments are focused onto the central unit control room from which all essential operation is directed.

The features of control centered about the boiler and its auxiliaries are as follows:

(a) The combustion control system is of the General Regulator Company all-electric type in which a master element, responsive to steam pressure, regulates air flow by induced draft fan inlet vane position, and fuel flow by exhauster inlet damper position. Furnace draft is controlled directly by forced draft fan inlet vane and outlet damper positions.

(b) Pulverized-fuel equipment controls, in addition to the feeder controller elsewhere described, include means for remote manual relatching of exhauster inlet and pulverizer air inlet trip dampers. The pulverizer inlet damper is controlled automatically in response to mill suction impulse while tempering air control is automatically produced in response to pulverizer outlet temperature. The controls are all centered in the main control room.

(c) The condenser type superheat controls are fully automatic in response to steam temperature and air flow impulse. These are centered in the main control room for necessary constant supervision.

(d) Feedwater control is the Bailey automatic three-element system which does all necessary regulation in the feed supply served by constant speed boiler feed pumps.

(e) The precipitator controls are centered on the fan floor adjacent to the rec-

(Continued on page 126)

The Conductivity Test— Important in Boiler Water Control

Primary application of conductivity tests is in determination of steam purity. . . . Also valuable in control of boiler water solids. . . . Certain limitations must be understood and corrections made for ammonia and carbon dioxide in steam. . . . Correction curves. . . . Use of Straub Degassing Condenser. . . . Conductivity test in blowdown control . . . Gallic acid neutralization

By **JOHN DREW BETZ** Chemical Engineer W. H. & L. D. Betz

THE CONDUCTIVITY TEST (or, more correctly, the determination of specific conductance) is an important boiler water control procedure, which has advantageous applications in most power plants. The test provides an accurate measurement of steam purity as well as a simple control for boiler water solids. The purpose of this article is to provide the power engineer with a review of the use and applications of this test as well as to describe the limitations of this method of control.

The use of specific conductance as a power plant control test is not new. It was first applied approximately 15 years ago. For several years after its development, the use of this test as a control procedure was generally confined to utilities and larger industrial power plants. Today, however, conductivity instruments are available which will suit the needs and budget of any power plant.

Specific conductance is inversely proportional to electrical resistance. Pure water is highly resistant to the passage of an electrical current, and therefore has a low specific conductance. However, if the water contains ions, the water becomes a better conductor of electricity and the specific conductance is increased. Inorganic compounds such as sodium chloride and sodium sulfate ionize when placed in solution. That is, they dissociate into positive and negative ions, which will conduct electricity in proportion to the amount of ions present. The conductivity test, therefore, is not specific for any one ion, but rather is a measure of the total ionic concentration. This test is extremely sensitive; less than one part per million of dissolved solids can be determined. Because of this fact, the primary application of this control test is in the determination of steam purity. However, this test is also valuable in the control of boiler water solids.

The basic unit of electrical resistance is the ohm. Since electrical conductivity is the reciprocal of resistance, the unique term "mho" ("ohm" spelled backwards) was chosen as the basic unit of conductivity. In the conductivity test. small amounts of electrical conductance are measured and the instruments are usually calibrated in micromhos (a micromho is a millionth of a mho). To calibrate a conductivity instrument to read directly in parts per million of dissolved solids (or some specific ion or compound) is not recommended, since such a calibration introduces an error into the instrument reading itself. The conversion factor from micromhos of specific conductance to parts per million will vary slightly with different waters; and to include a constant conversion factor in the instrument calibration is to introduce an unnecessary source of error.

Steam Purity-How it is Measured

Pure steam is a relative term. What can be considered a pure

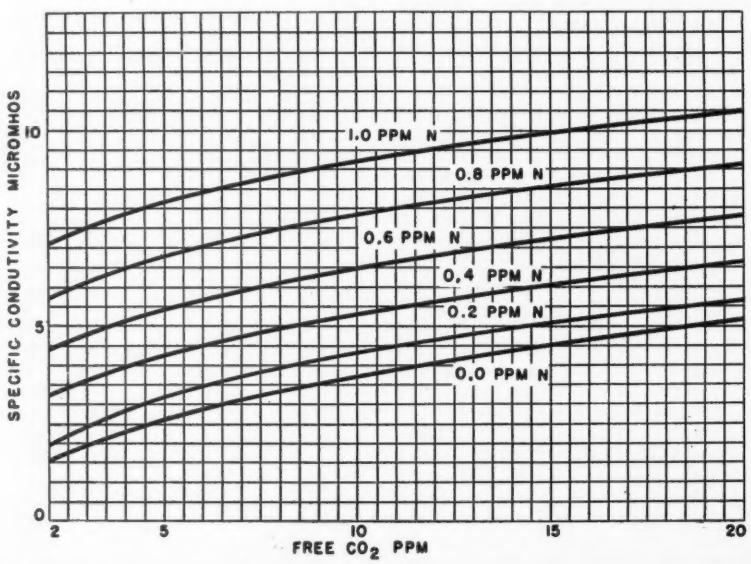

Fig. 1. Conductance correction curves for ammonia and carbon dioxide in conductivity test for steam purity. Method of use explained in text

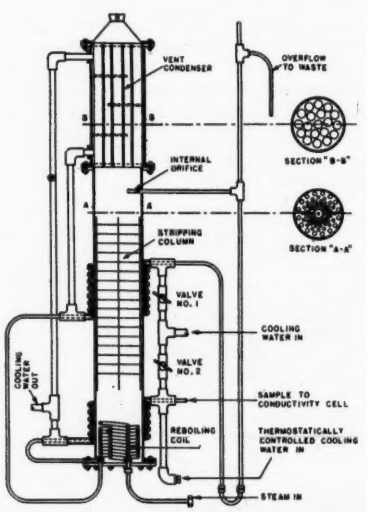

Fig. 2. Straub Degassing Condenser, used for continuous removal of ammonia and carbon dioxide from steam prior to conductivity test. Condenser may be installed ahead of conductivity recorder

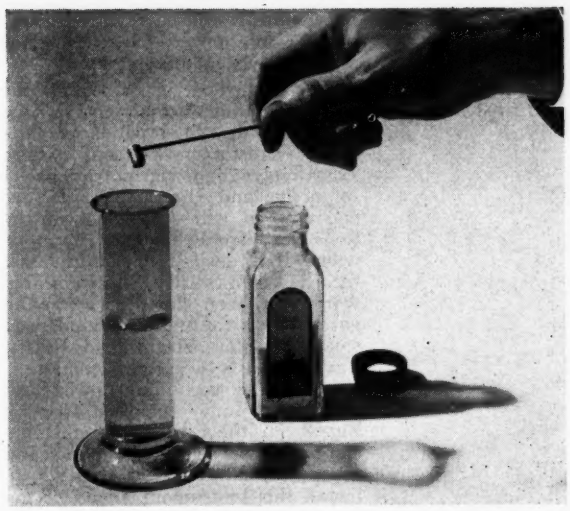

Fig. 3. CONDUCTIVITY TEST—STEP 1. Put 50 ml of sample into testing flask, then add two dippers (0.2 grams) gallic acid for neutralization

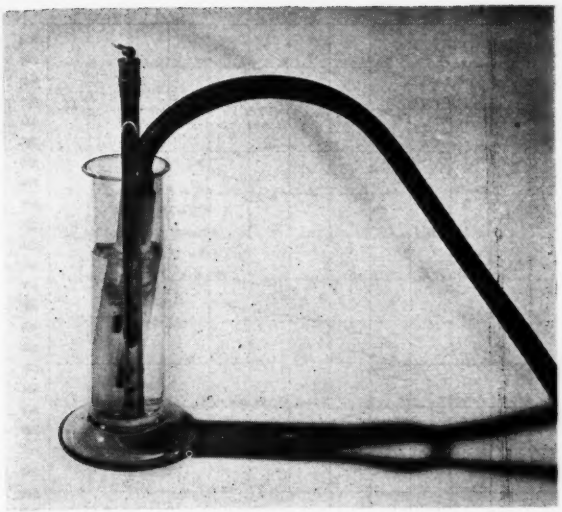

Fig. 4. CONDUCTIVITY TEST—STEP 2. Insert electrodes into sample, read sample temperature with thermometer provided for purpose, and set compensation dial on instrument

steam for one plant may be an impure steam for another. However, most industrial plants begin to think of an impure steam at a total dissolved solids concentration of three to ten parts per million in the steam. Prior to the use of the conductivity test a routine plant check for the degree of steam purity was not very practical. The various methods for the determination of steam purity can be summarized briefly.

The throttling calorimeter: — This formerly was a popular method of determining steam purity. In this unit, a sample of saturated steam is expanded through an orifice to atmospheric pressure. The total heat in the steam sample is greater than the total heat of saturated steam at atmospheric pressure and the excess heat in the steam sample will superheat the expanded steam or evaporate the moisture originally present in the steam sample. From measurements of the pressure and temperature of the inlet and outlet steam, it is possible to calculate the moisture present in the original steam sample.

Since the accuracy of the throttling calorimeter is approximately ±0.2 per cent moisture, this poor accuracy can mean an appreciable error in the solids content of the steam. For example, at a boiler water concentration of 4,000 ppm, a 0.2 per cent error would correspond to an error of 8 ppm solids content of the steam. As a result of this appreciable error, this apparatus is of little value in the determination of steam purity. A carryover problem of some magnitude must exist before this instrument can be depended upon to indicate impurities in steam.

Routine mineral analysis for chlorides, alkalinity, sulfates, etc;—This is of little value in the determination of steam purity. Like the throttling calorimeter, a mineral analysis only indicates appreciable contamination of the steam. The limit of accuracy of the various test methods is such that they cannot be applied where a condensed steam sample is relatively pure.

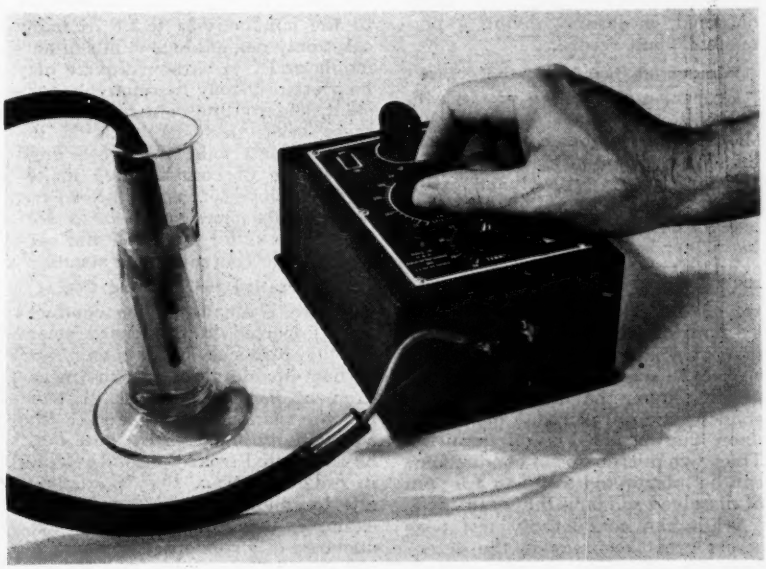

Fig. 5. CONDUCTIVITY TEST—STEP 3. Read conductivity direct from instrument. Full instructions with instrument

Total solids determination:—This is another method employed in the determination of steam purity. However, this method is cumbersome and time consuming, not lending itself to routine control. This method requires the collection of a sample of condensed steam, the evaporation of the sample to dryness, and the weighing of the residue. Since the presence of each part per million of solids in the steam will yield a weighable residue of only 0.001 grams per liter of sample, careful handling and technique is required. A well equipped laboratory is necessary for this determination and approximately four liters of sample must be evaporated to dryness for accurate results.

Conductivity test:—Since this is a relatively simple test and since the presence of less than one part per million of dissolved solids can be detected, it is apparent that, as a control test or steam purity, the use of the conductivity test is outstanding. Because of the advantages of this method, the determination of specific conductance of condensed steam samples has become prominent in the last few years and is now enjoy-

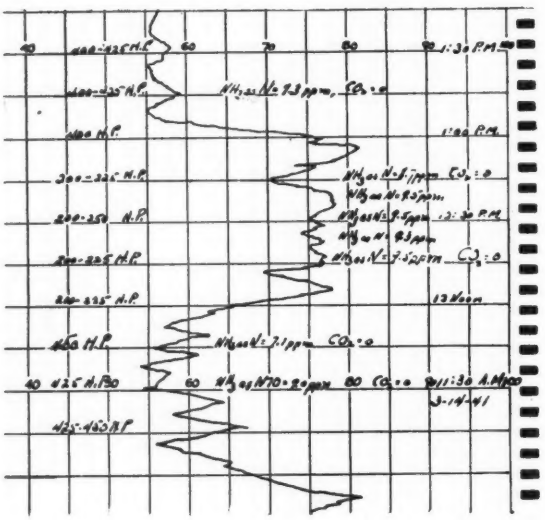

Fig. 6. Actual conductivity recorder chart from plant where ammonia in steam was between 7.3 and 9.5 ppm

ing wide-spread use. Continuous recording of the conductivity can be obtained, if desired, giving a permanent plant record.

Interpreting the Conductivity Test

Proper interpretation of the conductivity test must be made. It should be remembered that the conductivity test is an electrical measurement that is proportional to the specific conductance of the ions present as an impurity in the steam. In a condensed steam sample an average value for converting micromhos of specific conductance to dissolved solids is approximately 0.5 to 0.6 ppm dissolved solids per micromho of conductance. This factor is subject to some slight variation, depending upon the individual steam condensate measured, depending upon the specific ions of impurity. Thus, five micromhos of conductance can be interpreted as 2.5 to 3.0 ppm of dissolved solids in the steam.

While the conductivity test possesses great accuracy in the determination of steam purity, certain limitations must be understood. Unfortunately, some dissolved gases have a marked effect on the conductivity of water. Gases such as carbon dioxide, ammonia and hydrogen sulfide ionize in water solutions and can interfere with the use of this test for determining dissolved solids in condensed steam.

If ammonia is present in the condensed steam sample, a high conductance will result because of the high conductance of this gas, which may average 8 to 9 micromhos per part per million of ammonia, depending upon the form in which the ammonia is present. The effect of ammonia is greater than that of the average boiler water solid which may be present in the steam. Free carbon dioxide will also increase the conductance of a steam sample approximately one-half that of the average boiler water solid.

Fortunately these limitations do not prove to be a great disadvantage to the conductivity test. In many cases only negligible amounts of ammonia and free carbon dioxide may be present or may be relatively constant, and routine control check for these gases need be made at infrequent intervals. Where a high percentage of contaminated make-up is employed in a plant, however, it is usually necessary to make frequent checks for ammonia and carbon dioxide content of the steam.

Correcting for NH_3 and CO_2

Figure 1 illustrates the conductance imparted to condensed steam by the presence of ammonia and carbon dioxide gases. In the measurement of dissolved solids in steam by the conductance method, the conductivity imparted by these must be subtracted from the total reading in order to obtain the conductance due to solids in the steam. As an example, using Fig. 1, if the conductance of a condensed steam sample were 8.0 micromhos and the ammonia and carbon dioxide in this same sample were 0.2 ppm as N and 6.0 ppm as CO_2, a correction of 3.5 micromhos would be required, leaving 4.5 micromhos of conductance due to solids in the steam.

This procedure of correcting the specific conductance to give a true value for dissolved solids is generally satisfactory except where excessively high concentrations of ammonia and carbon dioxide are encountered, where these concentrations vary from hour to hour, or where it is desired to continuously record steam purity. Considerable work has been done in removing gases from a continuously condensed steam sample. Straub and Nelson developed a degassing condenser employing a scrubbing tower and stripping column, as illustrated by Fig. 2, for the continuous and efficient removal of both ammonia and carbon dioxide. It is possible to install this instrument ahead of the conductivity recorder, so that the specific conductance recorded is due to dissolved solids only.

Figure 6 illustrates the actual conductivity record at a plant where the ammonia in the steam varied between 7.3 and 9.5 ppm. The conductivity as shown by the chart varies between 55 and 82 micromhos. A record in a case such as this is of little value. Figure 7 is another record of the same steam after the installation of a Straub Degassing Condenser. The conductivity varies between 5 and 7 micromhos.

It is important that blowdown control be such that boiler water concentrations do not exceed certain limits, lest scale formation and carryover result. On the other hand, it is equally important that excessive blowdown be avoided, because of the heat units that are wasted as well as the additional chemical treatment required to react with the additional incoming feedwater. Thus, a system of control should be established so as to maintain boiler water concentrations within determined limits.

The factors limiting boiler concentrations and thus determining boiler

(Continued on page 132)

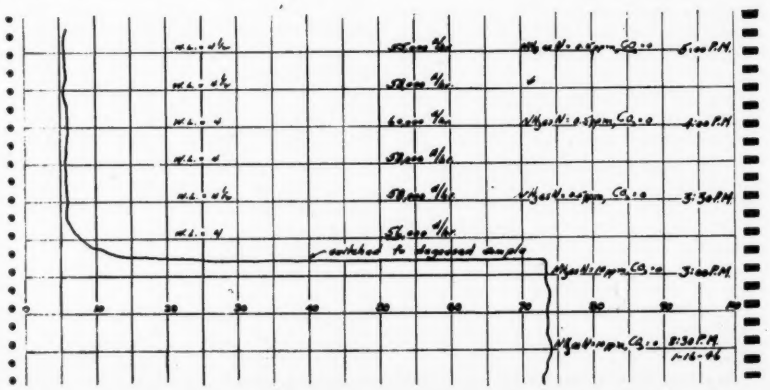

Fig. 7. Conductivity record of same steam as in Fig. 6 after passing through a Straub Degassing Condenser

Necessity for maintenance programs . . . Setting up a maintenance schedule . . . Use of the Log . . . Recording data . . . Keeping track of lubricating oil temperatures . . . Maintenance of regulating and control devices . . . Checking quality of lubricating oil . . . Dismantling the turbine.

Industrial Turbine Maintenance

By G. W. ANDERSON
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THE USE OF STEAM TURBINES for driving generating and mechanical equipment in industrial plants has developed rapidly during recent years. The size of the turbines used, the operating pressures and temperatures, together with the functions which they perform have all increased. The maintenance program has therefore become more involved and more important in order to assure continuity of service and realization of the high economic performance of which the equipment is capable.

It is not ordinarily possible to develop a maintenance organization in an industrial power plant comparable in extent with that in most of the larg central station power plants. Frequently the maintenance work is performed by mechanics employed in the maintenance of any and all equipment throughout the entire industrial property. A group of specialized mechanics for maintenance work on the power plant equipment exclusively is not usually carried on the plant payroll. For this reason the engineer in charge of the power plant must develop certain key men in his plant organization who can direct the work of the general mechanics doing a maintenance job. The general mechanic is usually a willing worker but he does not know the importance of many of the details in maintaining a turbine. Unless his work is supervised by someone who is familiar with the equipment, an incorrectly done maintenance job frequently results; not because it is poorly done, but because the man doing the job did not understand what was required. As industrial power plants develop in size and functions, a well trained maintenance supervisor becomes increasingly important.

A maintenance program is necessary. A systematic schedule of outages of the power plant equipment for inspection and repair must be set up. Frequently this is difficult in an industrial plant because of the fact that such outages must be scheduled to conform with the industry's production schedule. Nevertheless the power plant equipment must have its turn for inspection and, if necessary, repair. If this is not provided, unscheduled outages due to breakdown of the power plant equipment, are certain to result. Usually these enforced outages come at a time when they seriously impair the industry's production. It is up to the engineer in charge of the power plant to see that a schedule is set up for inspection and repair of the power plant equipment. And it is up to the management to cooperate with this engineer in arranging such a schedule. This seems logical and quite sensible, but many a costly outage of power plant equipment has resulted because such a plan was not followed.

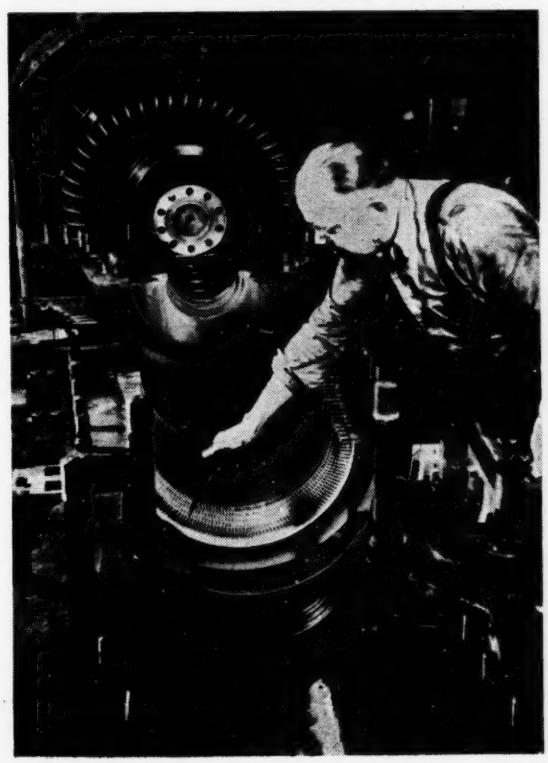


Fig. 1. Deposits of scale on blading formed by "carry over" from boilers will cause reduction in capacity or mechanical damage if not removed periodically or eliminated at the source.

Setting Up a Maintenance Schedule

In setting up a maintenance schedule the engineer must keep a record of the condition of the equipment and make frequent reference to the operating log. This record need not be complicated but it must briefly cover the condition of the equipment as found during each inspection, including dates and materials used for any repairs required. It is not possible to arbitrarily set up a definite length of operating time between general inspections of all turbines. In some cases one year is satisfactory. In other cases these general inspections may have to come more often, while in others a period of two years

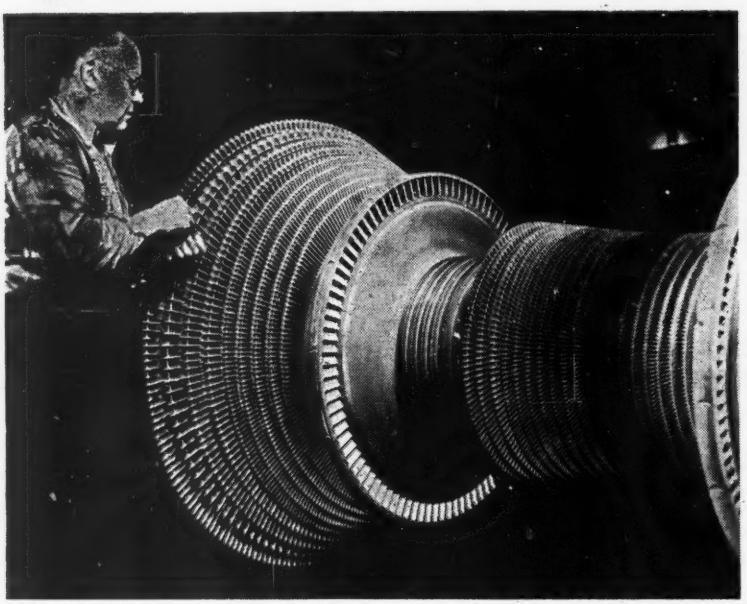


Fig. 2. Detailed inspection of blading assures that it is in good condition for the next operating period

more may elapse between general inspections. The scheduling of a general inspection depends on the operating performance, as indicated by the log, and the conditions of the equipment as found during the previous inspection. In the case of a new turbine it is generally recommended that it be opened for complete inspection at the end of the first year of operation. This inspection may reveal developments such as deposit of foreign matter in the blading due to carry-over from the boilers, erosion of blading due to moisture in the steam at the lower stages, accumulation of dirt or rust in the oiling system, or indication of mechanical distress of any of the internal parts. From this inspection the engineer can decide how long a period of operation is safe before the next inspection should be made, and schedule that inspection. If the conditions found are satisfactory, perhaps a longer operating period can be made before the next inspection. However, it must be borne in mind that inspections are made for the purpose of assurance that the equipment is in good condition — not for the purpose of making repairs long overdue.

By systematically checking the operating log the engineer can obtain considerable information for his guidance in setting up a maintenance schedule. Changes in pressures and temperatures always reveal a maintenance condition. The following are a few typical cases:

Recording Pressures

Stage pressures recorded at intervals under the same load conditions will indicate the cleanliness of the blading. If these pressures become greater under the same load conditions it is quite probable that carry-over from the boilers is depositing on the blading and is restricting the flow of steam. This indicates that an outage must be scheduled to mechanically clean or wash out this deposit before the capacity of the turbine is seriously reduced or a mechanical failure results. Improvement in boiler feedwater treatment has greatly reduced the danger of trouble due to deposits of carry-over in the turbine blading. It is now seldom necessary to clean out large quantities of baked mud as was frequently the case during the early stages of turbine and boiler development. However, even with the modern methods of treating boiler feedwater, and the use of high pressure and superheated steam, there are certain elements carried over with the steam that will create a deposit in certain sections of turbine blading. This condition must still be watched.

A general increase in lubricating oil temperature bears investigation. Frequently this is due to the oil cooler becoming dirty. A schedule for periodic cleaning of the air cooler should be set up whereby it is kept reasonably clean at all times. The formation of scale on the water side of the oil cooler tubes usually accelerates due to the increase in oil temperature it causes. Frequently the cleaning is delayed too long and the oil temperature becomes dangerously high before action is taken. The excessive oil temperature contributes to higher maintenance cost of the turbine as well as damage to the oil. The matter of keeping the oil cooler clean is a fundamental of operation which it would seem unnecessary to mention here, but is surprising how many plants neglect it.

A great many of the turbines used are designed for automatic extraction and/or non-condensing operation in order to supply steam at various pressures for industrial purposes. These turbines are equipped with regulators and control devices which must be properly maintained in order to give good service. By reference to the log and recording charts the engineer can determine just how well these pieces of apparatus are performing their

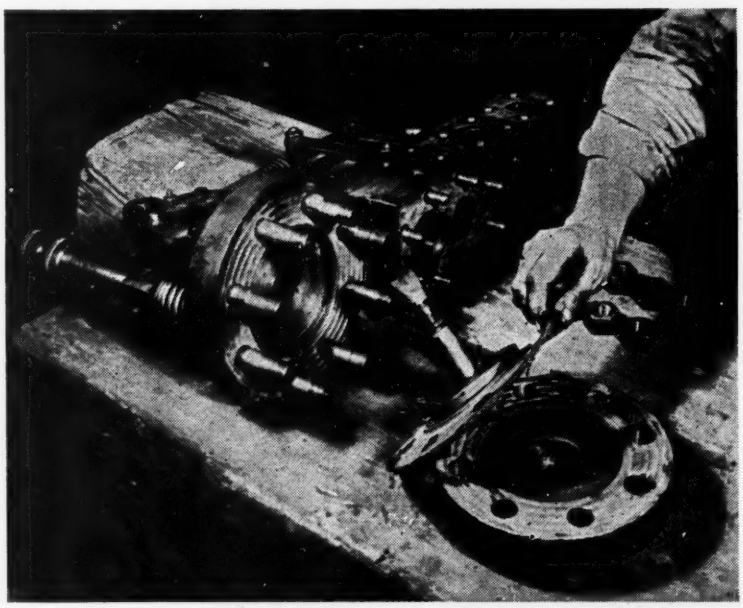


Fig. 3. Replacing a diaphragm that has had considerable service in an extraction pressure regulator is good insurance against failure in service

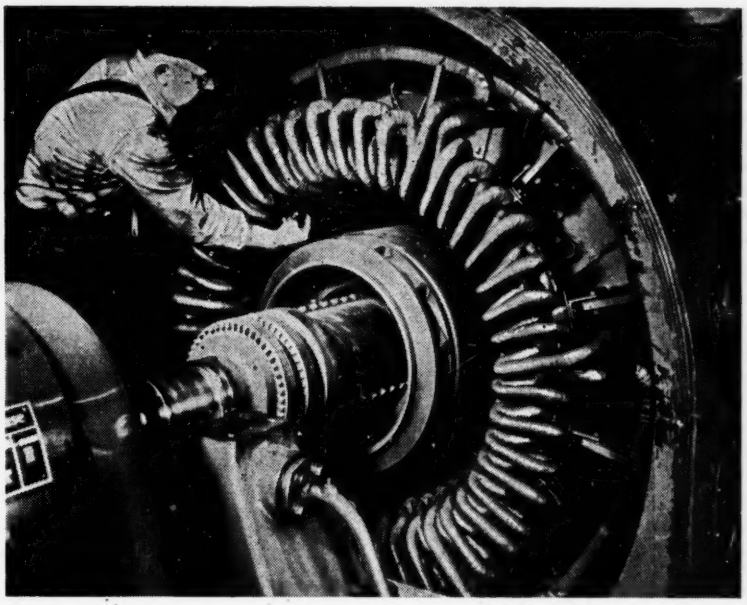


Fig. 4. Periodic inspection of insulation, lashing and blocking is essential in maintaining a generator in good operating condition

function. Sticky valves or relays will become evident by the appearance of irregular recordings on pressure or flow charts. Worn linkage or failing pressure regulator diaphragms will show up as irregular speed or pressure control. If action is taken when these irregularities first start to appear on the charts or records they can be eliminated by scheduling a regular inspection and cleaning of the control equipment. If this is not done an enforced outage may result from a control device becoming wholly inoperative. The replacement of pressure diaphragms which are a part of automatic control equipment should be given special attention. Don't wait until the diaphragm breaks and causes an outage before replacing it. Set up a schedule to renew all diaphragms at regular intervals. They are not expensive, but their failure due to lack of proper maintenance has caused many expensive outages.

Checking Lubricating Oil

Set up a regular schedule for the operators to test out the auxiliary oil pump and record the result of this test on the log. Set up a regular schedule to inspect the control valve and replace the diaphragm in the automatic regulator which brings this pump into service. This pump stands idle a large proportion of the time, and is much more subject to lack of attention than a piece of equipment, which is continually in operation. Turbines have been seriously damaged because the auxiliary oil pump was in poor condition and failed to start when the turbine was being shut down.

Set up a regular schedule for checking the condition of the oil in the turbine lubricating system. Most oil suppliers will gladly analyze a sample of their oil from your unit. Oil does not wear out, but it does become unusable due to contamination with water and dirt. Examine the strainer in the oiling system regularly. It will give you an indication of any foreign material getting in the oil. The appearance of flaked babbitt or bronze cuttings in the strainer, frequently enables the engineer to discover bearing wear before an actual failure occurs. This is a warning that demands action in checking operating conditions and perhaps scheduling an outage for complete investigation. Draw off a sample of oil from the bottom of the oil reservoir regularly. If water is found in the oil a campaign should immediately be started to locate the source of the water and eliminate it. Most turbine oils do not stand up very long when contaminated with water. Frequently a small amount of water in the oil will cause rust formation on the iron parts of the oiling system. Gritty particles of rust from this source will be carried by the oil to the bearings and journals causing serious damage. In many cases the quantity of water in the oiling system will not be sufficient to definitely appear in a sample of oil taken from the bottom of the oil reservoir. Therefore, although the sample does not show any water, a second step in the investigation is necessary. Examine the underside of the cover of the oil reservoir, or the upper side of a return oil line which runs only partly filled with oil. If a gritty formation of rust is found at these locations, there is or has been water in the oil which vaporized and then condensed on these relatively cool iron surfaces. Many of the turbine oils now in use contain inhibitors for the purpose of preventing oxidation and corrosion. If a case of rusting of the interior of the oiling system develops, it is well to confer with the supplier of the oil and obtain his assistance in eliminating the condition.

The development of excessive vibration is of course an indication of mechanical unbalance or misalignment, which demands immediate attention. However, in many cases this vibration may have been increasing over a long period of time, and earlier steps to eliminate it might have prevented an unscheduled outage. It is a good plan to measure and record the amplitude of vibration at regular intervals so that a small gradual increase in vibration can be noted and correction made during a regularly scheduled outage. Small weight or reed type vibrometers are available on the market for this purpose.

The work of making a general inspection requiring complete dismantling of the turbine, should be supervised by a representative of the manufacturer. With his experience he can pass judgment on the condition of blading, nozzles, valve gear and other parts which may be showing signs of wear. These may require immediate repair or it may be that replacement parts should be ordered for installation during the next regularly scheduled outage. Here again the thought must be to predict required repairs so that they can be made before the condition of the equipment becomes so bad that a breakdown disrupts the industrial production.

In going back over the record of enforcing outages, it is almost always evident that the outage could have been prevented had certain maintenance or operating details been watched more closely. In many cases these were simple matters as outlined in the foregoing. The control of this is in the hands of the man supervising the maintenance and operation of equipment. By setting up a systematic record and schedule for making inspection, normal cleaning and minor repairs, he can eliminate a great many enforced outages, and in many cases, prevent costly major repairs.

* * *

FOR EVERY TON of pig iron made in a blast furnace about 4½ tons of air are required. The solid raw materials entering the furnace add up to only 3¼ tons for each ton of hot metal produced. For each ton of steel produced in an open hearth furnace with a conventional charge of 60 per cent hot metal and 40 per cent scrap, about 100 lb of oxygen or 435 lb of air are required to promote chemical reactions.

Temperature Detector Wiring Circuits

A description of the principal types of temperature detectors in use today for determining the winding temperatures of large generators, motors and transformers. After describing the fundamental bridge circuit used to measure the resistance of the detectors the author considers the question of rotating equipment, switchboard equipment, the effect of the wiring between the machine and the switchboard and errors due to variation of supply voltage

By B. H. SMITH,
Electrical Engineer, Electric Machinery Mfg. Company, Minneapolis, Minn.

LARGE GENERATORS, motors and transformers are often equipped with devices which can be used to indicate the temperature at various internal points in the apparatus. Three basic types of electrical equipment are used for this purpose.

Older apparatus often used thermocouples. However, at temperatures considered safe for electrical apparatus, the voltage produced by a thermocouple is very small and special equipment such as a cold junction compensator, or a lead resistance compensator is required for acceptable accuracy. For this reason thermocouples are seldom used today.

Occasionally an operator may want to have an indication of rotor temperature. This requires special equipment consisting of a Kelvin bridge circuit with the rotor winding as one element of the bridge.

The more common system gives an indication of temperature of measuring the change in resistance of a coil of wire. These coils are called by various names such as "Thermohms," "Exploring Coils," and "Resistance Temperature Detectors." In this article they will be called simply "detectors." They are made of various metals, but copper detectors are generally used.

The resistance of the detector is measured by a bridge circuit. The circuit is somewhat complicated by the fact that leads of appreciable resistance and a selector switch to read different detectors are almost always involved.

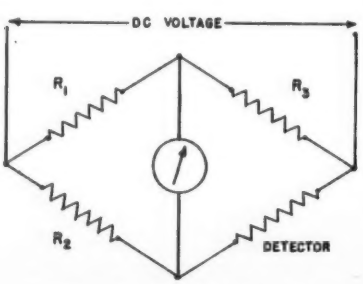


Fig. 1. The basic bridge circuit

The basic bridge circuit is shown in Fig. 1. The equipment made by one manufacturer consists of three fixed resistors and a d-c meter with offset zero. The resistors are chosen so that the bridge is in balance with the detector at some temperature such as 100 C. This is called the balance temperature, and at this point the reading is independent of the d-c voltage and lead resistance.

In the equipment made by another company, the resistors R_1 and R_2 are actually coils producing torque in the indicating instrument.

In the equipment made by a third manufacturer, slide wire resistors are used to balance the bridge for any reading, and the calibration on the slide wire gives the temperature of the detector.

It is generally desirable to read the temperature of several detectors in a machine. This is done by means of a transfer switch on the switchboard which connects one detector at a time into the bridge circuit. A test resistor of fixed value is often used to check the accuracy of the equipment.

Rotating Machine Equipment

Six detectors are generally placed in the stator slots of the machine between the upper and lower coil sides in slots equally spaced around the core. Additional detectors are often mounted in the incoming and outgoing air stream, and, occasionally, in bearings or oil lines.

Each detector consists of a coil of fine copper wire embedded in a moulded plastic strip. Two leads are brought out from one end of the coil, and a single lead from the other end.

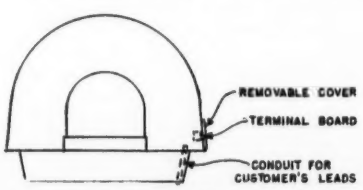


Fig. 2. Terminal board location on turbine-generators

Coils for mounting in an air stream are mounted on a rigid bar or encased in metal for protection. Detectors for use in the stator slots of machines are made in standard lengths, and the longest standard unit is used that will fit in a given core.

Three conductor cable firmly cleated to the end of the frame is used for wiring between the detectors and the terminal board on the machine. The terminal board is usually located near the frame foot where leads from the switchboard can be connected conveniently.

The circuits should be grounded to protect the operator and switchboard equipment in event there is a breakdown within the machine. Two types of terminal boards are available for this purpose. If the d-c operating voltage is taken from a source which may be grounded, a terminal board is used which grounds the "B" or white lead of each detector to the machine frame. If the d-c voltage is taken from a control circuit which should not be grounded, a special terminal board

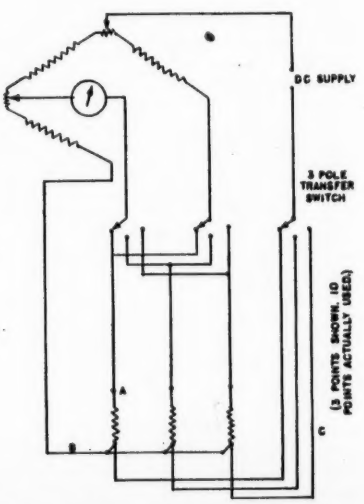


Fig. 3. Diagram of the Leeds & Northrup temperature indicator

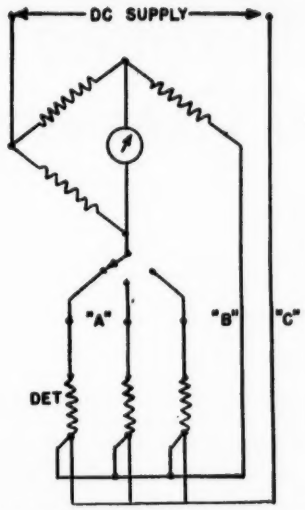


Fig. 4. Circuit using a single-pole transfer switch

is used which has a spring contact finger on the "B" lead of each detector. This finger is separated from a grounding strip by a "film cutout." This "cutout" is a thin disc of insulating material which will puncture and ground the detector if a dangerous voltage appears.

Unless the order specifically calls for the latter type of board, all machines are supplied with the solidly grounded type.

Switchboard Equipment

The switchboard equipment includes the bridge box, temperature meter, transfer switch, test resistor, and d-c voltage supply. One or more of these elements may be built into a single unit. The equipment offered by various manufacturers will be described briefly.

One manufacturer offers a temperature meter including built-in bridge and d-c voltage supply (operating from 115 v, 50/60 cycles, single phase) in various meter cases. The transfer switch and test resistor (if used) are mounted separately. The meter is a differential coil instrument actuated by a change in resistance of a detector which in turn unbalances the current through the two coils, giving a torque proportional to temperature. The transfer switch which they recommend is normally arranged to read four detectors or three detectors and a test resistor.

Another company offers all of the circuit elements as separate units. The bridge box is available for d-c circuits of 20, 125 and 250 v. The temperature meter is made in all standard meter cases.

A third company offers a panel mounted temperature indicator with enclosed bridge circuit, galvanometer, slide wire resistors, 3 pole-10 point transfer switch, and d-c power supply. A test resistor, if used, is mounted separately. This equipment is different from the others in that a reading is obtained by turning the slide wire knob until the galvanometer balances at zero, then reading the temperature on the movable scale.

This equipment also differs from the others in that a 3 pole transfer switch is recommended, and built into the standard unit. This eliminates the effect of contact resistance. As shown in Fig. 3, one pole switches the d-c to the "C" leads of the several detectors. The other two poles switch the galvanometer and the ratio arm *separately* to the "A" leads. Contact resistances in the supply and galvanometer circuits have no effect. High values of resistance are used in ratio arms.

This type of circuit also has the advantage that the amount of lead wire resistance does not affect the accuracy, provided the resistance of the "A" and "B" leads are equal. With direct reading meters, the readings are affected by variations in the supply voltage and by the value of the lead resistance at temperatures other than the balance temperature.

Transfer Switch

For circuits using a direct reading meter, the question arises as to whether a single pole or two pole transfer switch should be used. If a single pole switch is used the basic bridge circuit becomes as shown in Fig. 4.

Note that a separate lead must go from the d-c voltage supply to the terminal board on the machine. If this is not done, the resistance of the leads from switchboard to machine and back again is included in the detector arm of the bridge. When separate leads are used the resistance of a lead is included in each arm of the bridge.

With this connection the readings are influenced by the resistance of the wiring on the machine from the terminal board to the various detectors. It can be seen that the wiring from any detector in Fig. 4 is equivalent to Fig. 5. In this figure RM is the resistance of the lead wire on the machine from the detector element to the terminal board. It varies for each detector depending on the physical spacing and the size of wire used. The resistance of the wir-

(Continued on page 69)

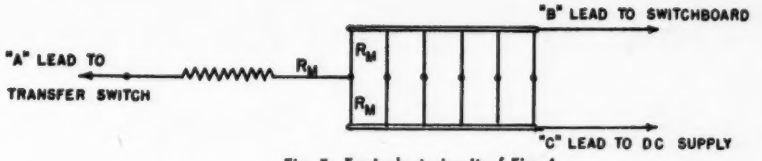


Fig. 5. Equivalent circuit of Fig. 4

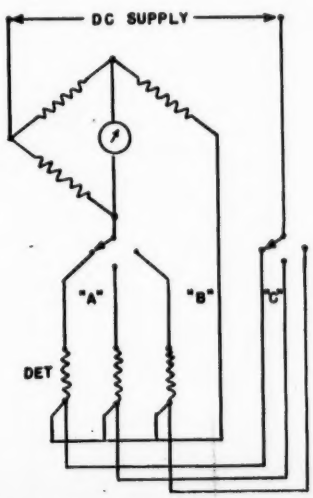


Fig. 6. Circuit using a two-pole transfer switch

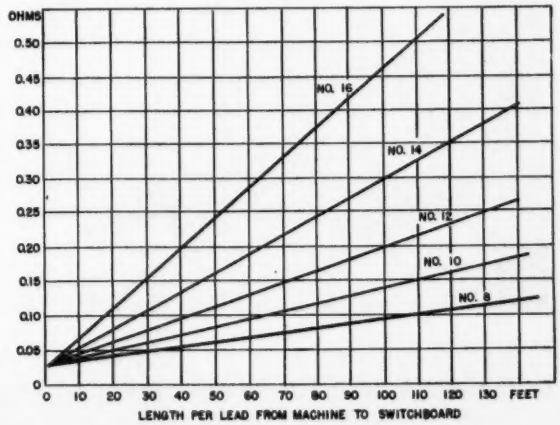


Fig. 7. Resistance of wiring to switchboard

How to Use Dry Ice in CO2 Scavenging of Hydrogen-Cooled Generators

By LESLIE H. HOUSEL

A NEW METHOD for storing and handling the CO_2 used in scavenging the hydrogen cooling system of electric generators is at present being adopted in a number of power plants. It has been in use for some time in bottling and industrial plants throughout the country. The new system stores CO_2 in the solid form, commonly called dry ice, from which the CO_2 gas is released by the method described and illustrated here.

In hydrogen-cooled generator installations, the general practice today is to use CO_2 as a "buffer" between hydrogen and air in the system, when hydrogen is being put into or withdrawn from the system. This is done to prevent formation of explosive mixtures of hydrogen and air.

When putting the generator in service, CO_2 gas forces all the air out of the hydrogen cooling system; then the hydrogen, at higher pressure, is introduced to force out the CO_2 and fill the system with hydrogen. When it is necessary for any reason to "scavenge" the hydrogen, CO_2 gas is again used to force the hydrogen out. (Editors Note:—Full details of the methods of scavenging hydrogen cooling systems will be given in a future article.)

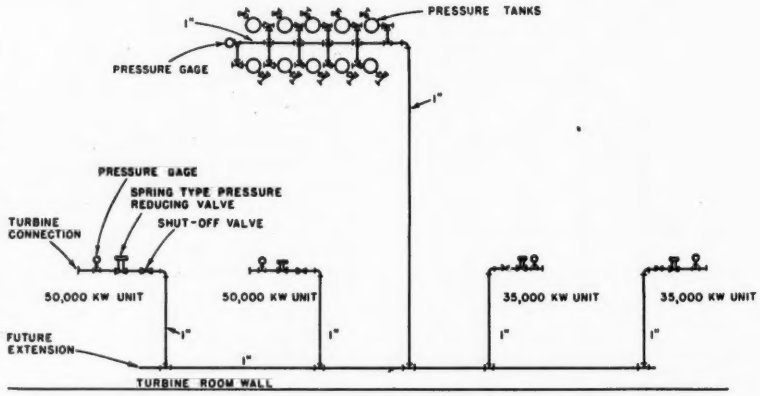


Fig. 1. Piping diagram for CO_2 scavenging system, using dry ice, in a power plant containing four turbine generator units

Here we are concerned with a new method of storing and handling the CO_2. In most power plants it has previously been the practice to use liquid CO_2 as the source of the CO_2 gas. This is delivered by the supplier in steel bottles or cylinders, usually under a pressure of between 800 and 900 psi. When allowed to flow through an expansion valve, the liquid turns to gas, which absorbs heat from the generator.

If the gas expands very rapidly it will cool itself to about —100F, thus freezing itself to a solid frost or snow. This is the process used in the CO_2 manufacturing plant, where the snow is collected and compressed into blocks called dry ice.

To use dry ice or solid CO_2 instead of liquid CO_2 as a source for CO_2 gas, the system shown in the attached illustrations is being used by a number of plants and is being encouraged by the commercial CO_2 manufacturers. A suitable number of special steel tanks, depending on the number of generating units being served, are lined up on a common manifold as shown in Fig. 1. These tanks must be designed for 1500 lb

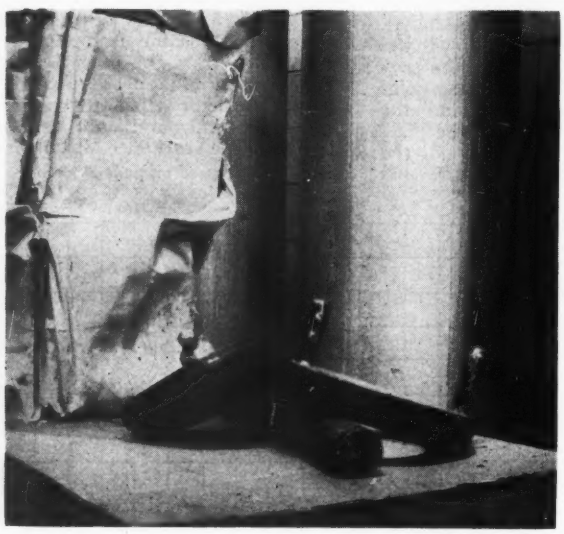


Fig. 2—Above. Clase-up view of tank cover for dry ice storage tank

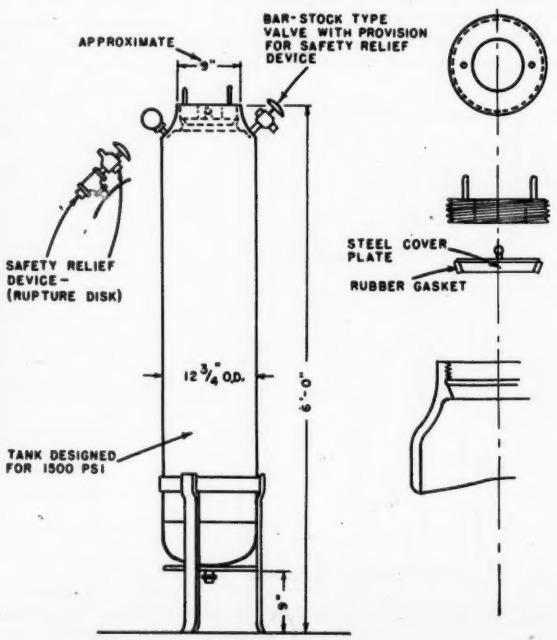


Fig. 3—Right. Construction of typical pressure tank for storing dry ice

service, with 1500-psi piping and valves connected so that any one tank may be put in service or isolated for recharging.

To charge a tank, a charge of dry ice is placed in it and the tank closed. As the tank and dry ice assume room temperature, CO_2 gas is formed and starts building up pressure. When the pressure reaches about 700 psi, the CO_2 becomes liquid. Since the liquid will occupy less space than the dry ice, the pressure will not exceed the CO_2 liquid pressure unless, of course, a higher temperature occurs. If this happens, the critical pressure point will be correspondingly higher.

A pipe line is run around the turbine room wall with a lead to each unit, as shown in Fig. 1. A pressure-reducing valve is placed in each lead, along with a pressure gage. This serves to protect the generator from excessive pressure. This is conventional practice; however, a few plants prefer to maintain zero pressure on the manifold until the time of gas usage, and then use hand control guided by the pressure gage. The rate of gas consumption is approximately 80 cfm. If this is exceeded, refrigeration may occur.

A typical pressure tank is built as shown in Figs. 2 and 3. Its features are:

1. About 12 to 13 in. in diameter by 5 ft high.
2. Round bottom for a 1500-psi pressure vessel.
3. Suitable rack or feet to hold tank in vertical position.
4. Swedged neck to permit machining a seat, and a thread for a cover retaining ring.
5. A cover with a cone rubber gasket is held against the seat by screwing down the retaining ring.
6. Two valves are required:
   (a) One for manifold connection.
   (b) One for opening to atmosphere so the cover can be put on. Even with this you will have trouble getting the cover on and tightening it, for the CO_2 gas forms so quickly.
7. A fabricated head can be substituted for the swedged head.
8. This tank will hold about 150 lb of dry ice.

Fig. 4. View of dry ice storage tanks, valves and piping as installed in typical power plant

TEMPERATURE DETECTOR WIRING CIRCUITS

(Continued from page 67)

ing is seen to be in a delta circuit, and, for analysis, this can be replaced by an equivalent Y. One leg of the star is in the detector arm of the bridge and one is in the fixed arm. The third leg is in the lead from the d-c voltage source and has little effect on the readings. The equivalent Y's for the various detectors are quite different, depending on the physical distance from the terminal board to the detector. Calculations show that for the No. 16 wire commonly used, the variations from this source will not exceed 4 C in machines up to 15 ft diameter.

CAUTION It is important to note that the transfer switch must be a type that makes a connection BEFORE the previous connection is broken. If this is not done, a very large current will flow through the temperature meter, and it may be damaged.

The variations in readings described above can be eliminated by using a double pole transfer switch. The basic bridge circuit becomes as shown in Fig. 6. The transfer switch can be used in either "B" or "C" leads. However, it is common practice to use it in the "C" leads as shown.

With all types of switchboard equipment, it is of the utmost importance that the resistance of the "A" and "B" leads to any one detector be equal within 0.03 ohms.

In the equipment made by one company, the resistances R^1 and R^2 are generally equal. In that case, resistance of leads "A" and "B" causes a small error which increases as the operating temperature goes further from the balance temperature. This error will not be serious except in cases where runs of 100 ft or more of No. 14 wire are involved.

In another manufacturer's equipment, resistances R_1 and R_2 are generally not equal, and lead resistance causes appreciable error at all temperatures. Each indicator is calibrated for a particular value of lead resistance, which must be specified when the indicator is ordered. The resistance of each "A" or "B" lead, measured from the terminals of the indicator to the actual detector coil in the machine, must equal this calibration value within 0.1 ohm to obtain readings correct within ±1 C.

As mentioned previously, the accuracy of the equipment using the three-pole transfer switch is not affected by lead resistance, provided the "A" and "B" resistances to any detector are equal.

Figure 7 shows the lead resistance for various sizes and lengths of leads from the terminal board on the machine to the switchboard. The figure of 0.03 ohms at zero distance is the resistance of the leads from the terminal board to a detector on an average small turbo generator.

Since there is generally one pole of the transfer switch in the "A" lead and none in the "B" lead, it is obvious that contact resistance will affect the readings. A resistance of 0.1 ohm will cause an error of 2.6 C.

The accuracy of the indicators operating on the differential coil principle is not affected by changes in supply voltage of 10 per cent above or below normal.

In the other types equipment, a change in supply voltage introduces an error which may be calculated as follows:

$$T = B - \frac{E_a}{E}(B\text{-}T_1)$$

Where T = actual temperature
B = balance point temperature, usually 100 deg C
E = normal supply voltage
E_a = actual supply voltage
T_1 = observed reading

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Why Don't We Do Something About Atomic Power Development?

Over three years have passed since the dropping of the atomic bombs on Hiroshima and Nagasaki yet little has been done by the power industry toward the development of atomic power plants. This article considers some of the problems involved in such development and urges greater interest and participation on the part of those who now guide the course of the power industry.

By **ANDREW W. KRAMER**, Editor, Power Generation

ENGINEERS, as a class, are not blessed with a superabundance of imagination. There are exceptions of course, but ask the average engineer whether a certain course of action or a certain scheme is feasible and he will immediately get out his slide rule and begin to establish a number of *safe* assumptions. If he does give you an answer it will be on the safe side with plenty of margin for uncertainties. The engineer, in other words, plays a safe bet, necessarily so, because that is the only way he can keep his job; he is not paid to take chances.

However desirable this conservative quality may be in dealing with everyday eengineering problems it has its shortcomings in the projection and development of new scientific discoveries. History is replete with the mistaken predictions of those who knew it couldn't be done. It takes a more daring, a more fanciful type of mind than the slide rule thinking of the engineer to see beyond the immediate engineering obstacles which inevitably stand in the way of any new development. The really great engineers, indeed, are those who possess imagination as well as engineering skill.

The development of the atomic bomb took imagination—the imagination of men like Fermi, Einstein, Lawrence, Conant and Hutchins. Hahn and Strassman had demonstrated the phenomenon of nuclear fission in 1938 but no scientist in the world at that time had any evidence that this nuclear fission could be made to sustain a chain reaction. Yet in March, 1939, Enrico Fermi approached the United States Navy Department and pointed out the possibilities of uranium both as a source of power and as a source of explosive reactions. This took both imagination and courage—courage of one's convictions.

We all know what happened as a result of Fermi's initiative; how, after five years of unremitting effort and the expenditure of two billions of dollars, we produced the atomic bomb but only those very close to the project, those concerned with overcoming the all but insuperable obstacles that arose all along the way, know how great a part sheer vision and imagination played in attaining final success.

Engineers, of course, did most of the work and they did a magnificent job. There is no intention, here, to detract, in any way from the great engineering accomplishments of the thousands of engineers who actually designed and constructed the great plants at Oak Ridge and at Hanford, but over and above all were the Lawrences, the Fermis the Conants and the Comptons—the men who staked their reputations and hundreds of millions of dollars on ultimate success. It is to their everlasting credit not so much that they achieved this success but that they had the vision and the courage to go ahead in face of apparently insurmountable obstacles.

Over three years have passed since the atomic bombs were exploded over Hiroshima and Nagasaki; exactly six years have passed since the first nuclear reactor went into operation at the University of Chicago and while there has been great discussion regarding the use of atomic energy as a weapon in war, there has been little active interest in the development of atomic power. True, several utility groups have

[1] The Chicago-Northern Illinois systems are supporting the University of Chicago atomic research program and the Detroit Edison and Consolidated Edison Companies have more than an idle interest in the subject.

been cooperating in various research programs [1] and at the present time power reactors are being constructed at several of the AEC laboratories but there has been no large scale interest on the part of the utilities in the actual development of nuclear power plants. With the extremely narrow margin between installed generating capacity and the steadily growing electric load, it would seem that the utilities would make a much more concerted effort to develop this new great source of energy.

It is understandable, of course, that the utilities' needs are immediate and that even under most favorable conditions, large scale atomic power development is a decade or more away but this is not the reason for the lack of interest. Nor is it lack of progressive spirit. No one who has occasion to visit modern utility plants can accuse the utilities of not being progressive. Their progressive tendencies, however, are along conventional lines.

The chief reason for the utilities' apathy toward atomic power development I feel, lies in the lack of imagination on the part of engineering executives who direct development in the industry. They seem to be much more conscious of the obstacles in the way of atomic development than they are of the possibilities.

Has there ever been a more exciting idea in the field of power generation than the possibility of operating say a 70,000 kw power plant on just *two ounces of fuel a day?* That idea alone, it would seem, should stimulate interest to the point where no obstacle would be seriously considered. There are many other fascinating prospects in atomic power, however. The possibility of building plants anywhere regardless of the proximity of water or fuel resources, the complete absence of smoke, the possibility of designing much smaller plants, of putting them underground, these to mention only a few. Over and above all is the matter of unlimited fuel supply.

How Much Uranium Is There?

This question about the supply of fissionable fuel is one that is most frequently asked by engineers. Unfortunately, uranium has for many years been regarded as a rare element. In a press interview shortly after the atomic bombs were dropped on Japan, no less an authority than Dr. R. A. Millikan pointed out that uranium was a rare material and that, that ruled it out as a source of atomic energy for power. Actually, uranium is not a rare element. It is widely scattered throughout the earth's surface but compared to other rather common elements it is relatively abundant. Before 1941, it was known that there were rich commercial deposits of at least 50,000 tons. These, at present are the sources of supply for the Hanford plants and other piles that have been constructed in various places throughout the world. While these rich deposits will be adequate to supply the world's needs for some time to come, there is no valid reason why the more scattered lean deposits of fissionable material should not be used. The commercial value of uranium is high enough to warrant reasonably high extraction and refining costs. Estimates have been made that the earth's crust contains 5 trillion (5×10^{12}) tons or uranium and 15 trillion (15×10^{12}) tons of thorium. As indicated by Dr. C. Rogers McCullough of the Monsanto Chemical Company in a recent address before the American Institute of Electrical Engineers, if these figures are realizable the amount of uranium exceeds the estimated coal supply of 3.2 trillion (3.2×10^{12}) tons on a weight basis alone. This becomes even more impressive when it is remembered that each pound of fissionable material will produce 34 billion Btu or 10 million kwh of heat which could be converted to 2,860,000 kwh of electricity. Each pound of fissionable material in other words is equivalent to 1420 tons of coal.

The possibility of using thorium was discussed in an article in these pages in the October issue [2]. This showed that it may be possible to produce a pound of new fissionable material while one pound is fissioning. In this process, thorium 232 is converted into uranium 233 which like U-235 is fissionable.

The "breeding" process has not yet been perfected but there is reason to believe that it will be. Even without the use of thorium, however, it should be evident that the 5 trillion tons of uranium should last us a long time. As explained in a previous article[3] uranium is present in the earth's crust in the amount of 6 parts per million. In current gold mining practice it is profitable to recover gold from ores that contain as little as 0.3 parts per million. Actually, therefore, a handful of rock or sand or gravel picked up anywhere on earth contains some 20 times as much uranium as is needed in the case of gold ore to make it commercially useful.

Atomic Energy in Mining and Refining

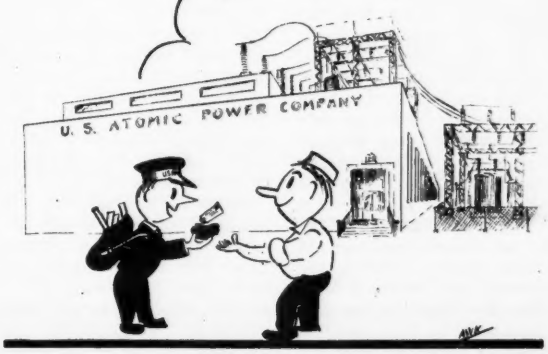
No doubt, considerable power will be required to operate mining and refining equipment in the utilization of low-grade uranium ores but that should prove no deterrant where a fuel with a heat value of some 34 billion Btu per pound is concerned. The atomic power plant indeed would lend itself very well to supplying such mining and refining operations. Needing no water (assuming that the gas-turbine type of plant was used) and almost infinitismal quantities of fuel and by its very nature adapted to operation away from congested centers, power plants could be erected anywhere.

So much for the supply of fissionable material. Let us now consider another problem that is frequently advanced as a severe hindrance to the development of practicable atomic power plants, the disposal of fission products. As is well known, in the operation of an atomic reactor, U-235, in the process of fission, is converted into a number of elements of substantially lower atomic weight. These products absorb neutrons and must be removed at intervals, before they reach concentrations which would reduce the efficient operation of the reactor. Naturally, these fission products are highly radioactive and dangerous. Some of them have half-lives of several thousand years.

The periodic removal of these

[2] The Importance of Breeding in Nuclear Power Development. By Andrew W. Kramer. Page 86.

[3] The Significance of the Nuclear Reactor in Atomic Development. By Andrew W. Kramer. March, 1948. Page 90.



Was there ever a more exciting idea than that of operating a 70,000 kw plant on 2 oz of fuel a day?

radioactive fission products and their disposal constitutes a major problem in the operation of a reactor. Before they can be disposed of, they have to be separated from the unused fissionable material and this also is a difficult operation since it has to be carried on entirely by remote control, behind suitable barriers.

The difficulty of the problem, however, should cause no discouragement. The principles involved are plain and at Hanford, at least, the problem has been solved to a sufficient extent to make the plant workable and without a single casualty in over four years of operation. As pointed out in the Smyth report, the maintenance problem was simple—*there could be no maintenance.* Once the conveying machinery which carried the partially fissioned uranium slugs to the chemical treating plant had been installed and placed in operation, it could not be serviced or repaired. It had to be made absolutely foolproof and reliable. Like the one-horse shay each part had to be as strong as every other part.

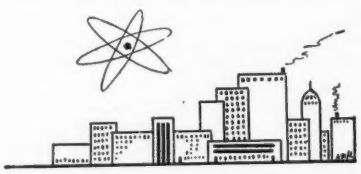
Secondly, the radioactive wastes must *all* be bottled up in tight containers and stored by being buried in the ground.

Rigid as these requirements are, surely they present no hopeless challenge to power engineers. Modern boilers and turbogenerators operate continuously for a year or more at a time and high voltage bus structures are quite as deadly as radioactivity if proper precautions are not observed. We live with these things in our daily work and think nothing of them but we are frightened of radioactivity.

Radioactivity is insidious because none of our senses are able to detect it even if it is present in lethal amounts. But like other problems in this field it has its solution. There are a number of instruments that will detect it even in minute quantities. With instruments of this kind personnel can instantly detect dangerous conditions or areas and retreat from these areas before harm has been done. The effect of radioactivity is cumulative and a person can be exposed to relatively high levels of intensity for short periods of time. In the Bikini tests, several days after test Baker, I was a member of a group that made a quick inspection of the target vessels on a small ship equipped with Geiger counters. As we approached the old Japanese battle cruiser, Nagato, the Geiger counters registered 100 Roentgen. The Roentgen is the unit by which radioactivity is measured and it is generally accepted that the maximum permissible continuous human exposure is 0.1 Roentgen. At the moment, therefore we were being subjected to perhaps a thousand times as much radiation as a person could safely absorb continually but, of course, we did not linger in the vicinity long. This instance is cited to show that one can be exposed to high radioactive intensities for short periods with no ill effects.

Disposal of Radioactive Wastes

As to the disposal of radioactive wastes, frightening as the problem may seem, there is a simple solution. Bury it in the ground. Fortunately, the quantities of material involved, even in the operation of a large plant, would be small and no great amount of ground area is needed. There is plenty of ground available to bury the material and a comparatively small number of feet of earth constitutes adequate shielding. While a few of the fission products have long half lives, most of them probably lose their greatest activity in a matter of weeks or months.



So, while the radioactivity problem is difficult, it is far from being insurmountable and it has been solved to a high degree at the Hanford plant. At Hanford, of course, all operations are carried out by remote control but that aspect should not concern those of us who are concerned with modern power plants. There are few things in the world today more *automatic* than a modern steam-electric power station. It is all but devoid of personnel, indeed, a modern high pressure plant could not operate efficiently or safely under manual control. If the boiler feed water supply to a high-pressure boiler operating at full capacity were interrupted the boiler would run dry in a minute or two in the absence of other controls.

Fortunately the control of a nuclear reactor is simple. It is merely necessary to insert or remove suitable neutron absorbing rods to maintain the operation of the reactor at any level within the limits of its designed capacity. While the details of the control used at Hanford are not generally known, the fact that the Hanford plant works is ample proof of the fact that the control problem there has been solved.

As a matter of fact, viewing the problem of atomic power development as a whole, despite certain basic difficulties, there is no element in it that is not capable of solution by the application of continued and concerted engineering effort. The greatest obstacle curiously enough has nothing to do with any of the factors here considered. It is the low cost of coal. With ample coal still available at from 5 to 7 dollars a ton, there is little incentive, from a purely commercial viewpoint to develop atomic power plants.

The commercial viewpoint, however, is not of primary importance at the present time. Too many discussions on atomic power before engineering groups have considered the subject from the standpoint of cost. Costs cannot be ignored, of course, but it is too soon to argue about economics, supplies of fissionable material and time scales. A recent report of the Atomic Energy Commission points out that it will be some 20 years, even under favorable circumstances, before it would be possible to have any considerable proportion of the world's power supply replaced by nuclear sources. If anything, this is an understatement. It probably will be much longer than 20 years before even a small portion of the world's power can be supplied from nuclear power plants, but that is no reason for us, now, to sit and wait.

If those responsible for the operation of our present power systems ever hope to utilize nuclear energy, it is time to begin now—to engage in extensive experimental work, to begin to accumulate factual data upon which the atomic power plants of the future will be built.

A Question of Survival

At a convention of the Controllers Institute of America, Chancellor Robert M. Hutchins of the University of Chicago said recently, "Any large industrial concern that hopes to be in business twenty-five years from now should know what this new weapon, this new physical phenomenon, this new source of energy, this new tool, can do to it and for it." While these words were addressed to a particular group, Dr. Hutchins made it ever so plain that they were addressed to *any* company, not merely those which can see a direct application of nuclear science to their business right now.

Well, as the Electrical World put it in an editorial, if there be any merit to Hutchin's advice then the electric power industry is certainly one which should act upon it. Judging by the volume of 30-year bond issues it has been selling, the electric power industry expects to be in business twenty-five years from now and, in view of what we already know, it is reasonable to assume that no industry will be more affected by or concerned with atomic energy than the power industry.

The problems are many and difficult but the way is clear. The pattern for the nuclear power plant is set; it will be a thermal plant utilizing a nuclear reactor as a source of heat with either a gas or steam turbine as a prime mover. It is as simple as that, but it is high time that we get started.

The Design of An Atomic Reactor

The following description of the design of an atomic reactor was abstracted from a paper before the American Institute of Electrical Engineers at Washington, D. C., on October 6, by Dr. C. Rogers McCullough, of Monsanto Chemical Company. The figures should be of interest to everyone who has thought about the possibility of producing power from nuclear energy. As Dr. McCullough points out, his design is based upon the design of a reactor used in MIT Lecture notes used at the Seminar in Nuclear Science and Engineering, in 1946.

ATOMICS

THERE is a promising approach to every known problem in the design of a nuclear reactor. In order to illustrate these problems and the approach to their solution a reactor design with arbitrary constants is here presented. The amount of moderator and U-235 is taken approximately the same as for the reactor used in the MIT Lecture Notes[1]. Since the design given here is not the same as the MIT one, the amounts are in error but will serve to illustrate the important points.

The problem: Design an experimental nuclear reactor which will be a pilot plant for a reactor for a power plant producing 10,000 kw of electricity.

Tables I and II give the important data for a reactor to fill the requirements set forth and from these numbers the reactor can be visualized, always remembering that this is not an actual reactor design.

A thermal reactor was selected since this type appears to be well suited for power generation because the bulk of the moderator makes heat removal easier. Thermal reactors also have a minimum of fissionable material.

Graphite is one of the good moderators because it is cheap, available, has good nuclear properties,[2] and excellent high temperature properties; it also has the precedent of having been used in the Hanford reactors and several others[3].

Helium was chosen for the coolant because of its excellent heat transfer properties, its nuclear and chemical inertness and its relative cheapness.

A gas cooled reactor has been selected as one of the types of reactors that might be used. It is the simpler one and lends itself to improved power generation by the use of the gas turbine. In this experimental installation, however, it would be expected that a steam boiler and a conventional steam turbine and generator would be used. Other coolants have been considered, including liquid metals and water, each having its merits.

The figures for the constants of the reactor that were assumed would be arrived at after careful study in the case of actual reactor design. This study would cover the interrelation of size, shape, amount of uranium, volume of voids, coolant

(Continued on page 136)

TABLE I

ASSUMPTIONS

TYPE OF REACTOR: "Thermal" (neutrons at about 0.02 ev.)

MODERATOR: Graphite
32.0 metric tons = 35.2 short tons = 70,400 lb.
Density 1.6 grams per cm^3.

FUEL: Uranium 235 substantially pure.
25 Kg = 55.0 lb = 106.2 gram atoms = 6.45×10^{25} atoms

SHAPE: Right cylinder, height equal to diameter.

FUEL CHANNELS: 10cm x 10cm. (3.94 in. x 3.94 in.).
50% fuel unit, 50% gas passage running top to bottom of cylinder.

POWER LEVEL: Maximum 35,000 kw of heat
119,000,000 Btu per hour.
This is an experimental reactor and is expected to be operated at various levels below maximum as required.

VOIDS: (Gas passages) 30% of volume.

SURFACE TO VOLUME RATIO OF FUEL ELEMENTS = 10.0.

EFFICIENCY: 28.6% overall heat to electrical power.

COOLANT: Helium.

TABLE II

CALCULATED DATA

REACTOR SIZE: Radius 166 cm = 65.5 in.
Diameter 332 cm = 131 in. = 10.9 ft.
Height 332 cm = 131 in. = 10.9 ft.

GAS PASSAGE AREA:
Total $2.58 \times 10^4 cm^2 = 0.400 \times 10^4 in^2 = 27.8 ft^2$
Per Channel 50 cm^2 = 7.75 in^2 = 0.0539 ft^2

GAS PASSAGE VOLUME: $8.58 \times 10^6 cm^3 = 0.524 \times 10^6 in^3 = 303\ ft^3$

NUMBER OF FUEL CHANNELS: 516
Approximately 13 on a radius

FUEL ELEMENTS:
Total Weight: 13.7×10^6 grams.
Total Volume: (solid graphite) $8.58 \times 10^6\ cm^3$
Consumption of U-235
—operation @ 35,000 kw of heat = 32.2 grams/day.
—operation at 1000 kw of heat = 0.92 grams/day.
Time to reach 10% depletion at full power = 77.7 days.
Atoms fissioned to atoms in fuel element at 35,000 kw of heat
$= \frac{1}{8.35 \times 10^6}$ per day.

Atoms U-235 fissioned to U-235 atoms present $= \frac{1}{777}$ per day

Heat Flux: At 35,000 kw of heat = 39,200 Btu per hr ft^2

[1] MIT Lecture Notes. Seminar in Nuclear Science and Engineering, 1946. Application of Elementary Pile Theory in the Design of a Power Pile, pp. 193-204.

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

Winter Hazards of Industrial Workers

Studies by Metropolitan Life Insurance Company indicate that 40 to 50 per cent of all days lost are attributable to colds . . . Cost of colds . . . Susceptability to colds varies with different people . . . Climate has little effect on frequency of colds . . . Frostbites and Chilblains

By DR. W. SCHWEISHEIMER

THE COMMON COLD is the most prevalent and the most highly infectious of all the communicable diseases. Although wage-earners often endure colds without staying away from work, the common cold is nevertheless responsible for more lost time in industry than is any other single cause of disability. According to a study of the Metropolitan Life Insurance Company, various studies indicate that from 40 to 50 per cent of all days lost from work are attributable to colds and their complications.

It has been conservatively estimated that the toll of the common cold in the United States is at least one working day per employee per year. If that is so, the Metropolitan Life says in their study on the cost of the common cold, there will be more than 60,000,000 days lost to industry a year because of colds. At an average daily wage of $7, the loss in wages totals more than $420,000,000. The cost of drugs and medical care must be added. On the estimate that every family in the United States spends on an average of $10 a year for drugs and medical care in the treatment of colds, the total amount spent for these items would be in the neighborhood of $400,000,000. Another factor is the cost to employers resulting from lost production and disrupted routine. Though it is not possible to estimate this loss in exact figures, it is certain that the annual cost of colds to employers is very considerable.

On the basis of the figures mentioned, the Metropolitan Life has estimated that the cost of the common cold to the American people is well over a billion dollars a year. Other estimates state that the annual cost of all the sniffling and coughing produced by colds is as high as two billion dollars,—about the amount of money which was spent to develop the atomic bomb. Any disease that runs to such astronomical figures in cost must be rated high in the list of enemies of the public health.

Different Workers are Different

A machinist is working in a well-tempered room in which the door is opened occasionally for a short time, —and every time he starts sneezing or may feel pain in his right ear. Another machinist who is working next to him, cannot understand why that is so. He enjoys nothing better than a rush of fresh air from the open door or window even on days when the weather is chilly. And both of them are right! People are different.

Colds are frequently caught by a distant part of the body. An industrial worker cannot avoid working near a drafty door—incessantly he feels a draft at his right arm. The next day, however, he does not suffer from an arm ailment, but from a sore throat. Another man got wet feet while he was walking through a snowstorm to his plant, —a cold of the bowels was the result.

The weather has influence on the frequency of colds,—no doubt about that, a cold is a particular health hazard of winter weather. Still the climate, strange as it sounds, has less to do with colds than we usually believe. *There are just as many colds in Southern California as there are in cold New England or in windy Chicago or in the province of Ontario.* Getting accustomed to the weather may beat the inclination to repeated colds: the weather-proof, the locomotive engineer in his drafty cab isn't as likely to catch cold as the passengers in the stuffy cars behind. Infection with cold germs plays an important part. Dr. T. B. Paul and Dr. H. L. Freese made some interesting experiments in sub-arctic Spitzbergen. Miners live there in steaming, overheated houses which they leave to walk to their work through bitter cold and terrific winds. Though the conditions seemed just right for the contraction of colds, the miners showed no sign of illness. But when a steamer arrived and a sniffling crew came ashore, 84 of the 500 people in Spitzbergen got a cold.

Still when the first signs of a cold appear we may be able to check its progress by proper methods. Heat is essential for prevention and treatment of cold—whether applied externally in form of a hot bath or shower, followed by hot compresses around the neck, or use of an electric pad,—or whether internally promoted by hot tea or lemonade, mulled wine etc. All kinds of diets are recommended to prevent a cold, particularly an abundance of vitamins in form of additional tablets. *No reliable proof has been given that addition of vitamins to the normal food will prevent colds or infections.* Keeping the bowels open is most important, an occasional laxative or enema may prove helpful in such cases at the onset of the cold.If matters get worse, do not fail to consult your doctor; it might save you unpleasant complications and a lot of working days. If fever is present, rest in bed is frequently a cure-all. Some day we may have a specific

treatment for colds. So far such treatment has not materialized.

Frostbites and Chilblains

Frostbites and chilblains are like old wounds: the damage done is felt for years afterwards. The circulation of frozen hands and feet should be restored slowly. It is an old rule not to expose frozen limbs to a hot stove or fire, since severe pain and lasting damage may result.

Two types of men are particularly exposed to the hazards of frostbites and chilblains. There is the fat and somewhat phlegmatic type, with rough, dry skin on the back of the upper arms and on the legs below the knees. There is, on the other hand, the thin, highly strung, rather nervous type, with a general tendency to cold and bluish limbs. Representatives of the latter type have frequently catarrhs of the respiratory organs as well.

Cold is the external cause of chilblains. Footwear which is too tight, is a common cause. The blood cannot circulate properly if the foot is pressed by a tight shoe. The skin of the foot cannot be properly nourished this way. Tight hose may cause the same effects, and so do tight gloves on hands and fingers. Toes and heels are mostly affected. Chilblains usually make their first appearance in damp cold weather and disappear during the summer months.

Chilblains are red or bluish and swollen, of round or oval shape. Most unpleasant is the continuous itching and burning sensation, it drives the patient to distress and prevents him from sleeping. These sensations are more marked when there is a sudden change from a cold to a warm atmosphere, e.g. when a worker coming from outdoors enters an overheated room. Sometimes the lesions are fissured and cracked and this is commonly called "broken chilblains."

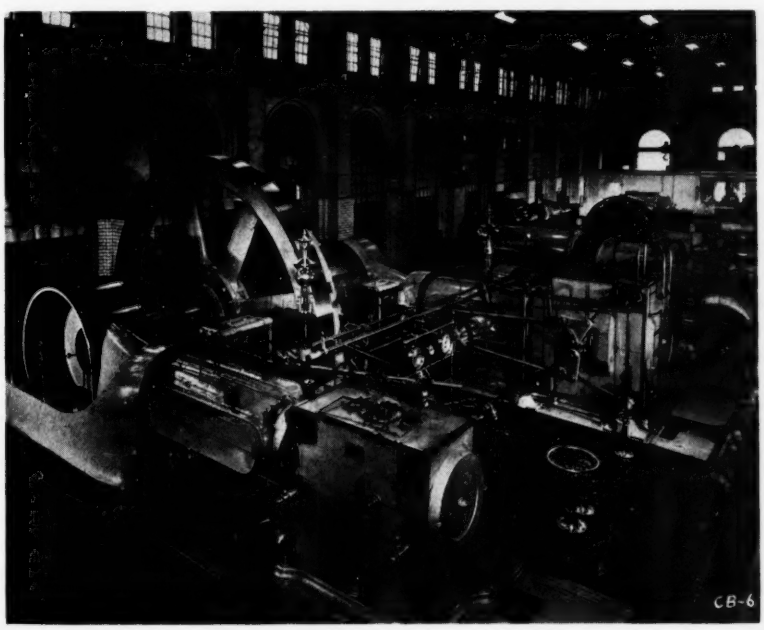
For prevention of chilblains warm and roomy shoes are essential. Shoes which have the proper shape and the right size, still may be too small for the foot if woolen stockings take too much room. Laces should not be tied tightly in cold weather. Running barefoot in summer on sand or grass is an excellent exercise for the circulation of the blood. From late fall onwards a foot bath of salt water, with the chill taken off, may be taken every night. The feet then should be dried thoroughly with care, and rubbed vigorously with a rough towel to stimulate the circulation.

There are many local applications to relieve the unpleasant sensations. Broken chilblains need careful treatment because an infection of the whole leg may result from a small injury of the foot.

Old Corliss Retires After 47 Years Service

A CORLISS ENGINE which has faithfully served in the power plant of The National Cash Register Co., of Dayton, since the turn of the century is about to take its rightful place in a special Hall of Fame.

Old "Number 1561," as it is affectionately known in the plant, will be on display in its retirement, alongside an airplane flown by the Wright Brothers, a wooden gear grist mill driven by water wheel, a Conostoga wagon, a Concord coach, a couple of ancient railway locomotives, a covered bridge and a restored canal lock.



Undefeated by 47 years of operation this old corliss at the National Cash Register power plant is to be retired to provide space for two new 5000 kva turbo-generators

The special Hall of Fame which it will occupy is located in a park in Dayton near the National Cash Register plant—a gift to the city made by Colonel E. A. Deeds, that company's Chairman of the Board.

Colonel Deeds, in appropriate ceremonies held recently, turned the shutoff valve that silenced "Old 1561" for the last time. It was a nostalgic occasion for Colonel Deeds, because it was he who first turned that valve which started the faithful engine back in 1901 when she was brand, spanking new and considered the latest and best of power plant equipment. Col. Deeds was then Superintendent of the power plant.

Workmen are now engaged in dismantling the Cooper Corliss which, according to officials of the company, has performed its job of furnishing power to operate its machinery almost continuously for nearly five decades. Except for periodic minor overhauls and repairs, the engine has never let us down, Col. Deeds declares.

The space occupied by "Old 1561" will be taken soon by two 5000 kva turbo-generators.

The Corliss engine was built by The C. & C. Cooper Co., of Mount Vernon, Ohio, which is now The Cooper-Bessemer Corp.

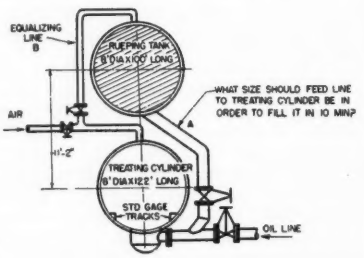
A TELEPHONE in your automobile works only when you are close enough to receive from a radio station in the system. In time a call may catch you even in the Ozarks. So far, however, service is available only along three routes: Chicago to St. Louis, New York to Albany, and —longest and newest—Washington to Boston.

Finding Size of Filling and Equalizing Pipes

Original Question No. 387

Submitted by B. E.

IN THE diagram are two tanks, one containing a treating oil and the other the wood to be treated. It is required by the process that the lower tank be filled from the Rueping tank in ten minutes. B. E. is not so much interested in an exact answer as he is in a step-by-step accounting of the method used. He would also like to know how to calculate the size of the equalizer line under operating conditions. In the October issue of POWER PLANT ENGINEERING I. A. B. gave an answer


EQUALIZING LINE B
RUEPING TANK 8'DIA X100' LONG
WHAT SIZE SHOULD FEED LINE TO TREATING CYLINDER BE IN ORDER TO FILL IT IN 10 MIN?
AIR
A
TREATING CYLINDER 8' DIA X 122' LONG
STD GAGE TRACKS
OIL LINE

figured in a different way from that presented in the two accompanying answers. (Ed.)

(Ed. Note: Some answers to questions in the Q & A section are of such general interest or so well done that they warrant publishing as complete articles. Such is the case with these two answers by Mr. Yavitch and Mr. Slote.)

(Note also that Mr. Slote calculates the time it takes to empty the Rueping tank, whereas Mr. Yavitch calculates this and the size of pipe required to empty the tank in 10 min.)

Answer No. 387

By L. Slote

IN DETERMINING the time it takes to empty the vessel in B. E.'s question the important facts that must be known are: the velocity of the fluid, the size of the orifice, the quantity flowing per unit of time, and the volume of the fluid. Armed with the above facts the solution to any emptying problem of a vessel becomes one of mere routine calculations. However, as the case may be, the volume of the fluid is a variable, and also the height of the fluid is a variable. Since the volume and the height vary, the mathematical approach to this problem becomes involved and beyond the scope of this article.

Since the time it takes a fluid to flow out of a vessel is dependent upon the volume of the fluid divided by the quantity flowing per unit of time. ($t = Vol/Q$). The quantity flowing per unit of time is equal to the area of the orifice times the velocity of the fluid flowing through the orifice. This value is theoretical and is modified by a constant known as the coefficient of discharge (C_d) which is always less than unity. The effect of this constant is to increase the time it takes the fluid to leave the vessel.

The manner in which this particular problem was solved was by an empirical method. The vessel was divided into several segments according to scale as shown in the accompanying drawing. The average height of each segment above the orifice was measured and recorded. Knowing the average height of each segment, the velocity of each segment flowing through the orifice can be easily computed. ($v = \sqrt{2gh}$.) Since we now know the velocity of each segment and the area of the orifice, the quantity flowing per unit of time through the orifice can now be determined. ($Q = C_d \times a \times v$) Having computed the volume of each segment and the quantity flowing per unit of time, we now can find out how long it will take each segment to leave the vessel. This is done by dividing the volume of each segment by the quantity of each segment flowing per unit of time. The figure now obtained is the time it takes each segment to leave the vessel through the orifice. The sum of all these individual times gives us the total time that it takes to empty the vessel.

From my calculations, the total time is 29.1 minutes. Solving the problem by the mathematical method the time it takes to empty the vessel is 29.40 minutes. The larger the number of segments we use in the empirical method, the nearer our answer approaches the mathematical solution.

The following shows the procedure of the empirical method and the results as applied to B. E.'s problem of emptying an 8 ft x 100 ft tank of water through an 8 inch pipe. The answer as shown on the following page is the time it takes to empty an 8 ft x 100 ft cylindrical tank of water from a *height equal to its diameter.*

The mathematical answer is dependent on the following equation:

$$A\frac{dh}{dt} = C_d \times a \times \sqrt{2g\,(h + r)}$$

$g = 32.2$ ft per sec^2

See Fig. 1.

A is equal to the longitudinal cross-sectional area.

The solution of the above equation is beyond the scope of this article.

The following drawing will show the set-up of the "Empirical Method." Fig. 2.

"A" = cross-sectional area of segment
"C" = chord
"h" = height from Datum line to midsection of each segment
"a" = area of orifice

Necessary Formulas

$V = \sqrt{2gh}$

$Q = C_d \times a \times V$

$t = \frac{Vol}{Q}$

$Vol. = A \times L$

$$\text{"A"} = \frac{4h^2}{3}\sqrt{\frac{C^2}{4h^2} + 0.392}$$

$C_d = 0.61$

$a = 0.348$ ft^2

$L = 100$ ft

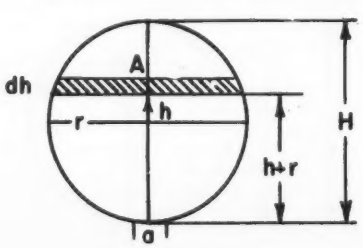


Fig. 1

Table I

A ft^2	Vel ft/sec	h ft	a ft^2	$C_d \times a$	Q ft^3/sec	Vol ft^3	t sec
A_1 3.615	21.92	7.5	.348	.212	4.65	361.5	77.6
A_2 6.207	20.4	6.5	.348	.212	4.33	620.7	143.5
A_3 7.306	18.8	5.5	.348	.212	3.98	730.6	183.5
A_4 7.992	17	4.5	.348	.212	3.6	799.2	222
A_5 7.992	15	3.5	.348	.212	3.18	799.2	251
A_6 7.306	12.7	2.5	.348	.212	2.69	730.6	271
A_7 6.207	9.83	1.5	.348	.212	2.08	620.7	298
A_8 3.615	5.68	.5	.348	.212	1.205	361.5	300
						xxx	
						total	1746.6 sec.
						or	29.1 min.

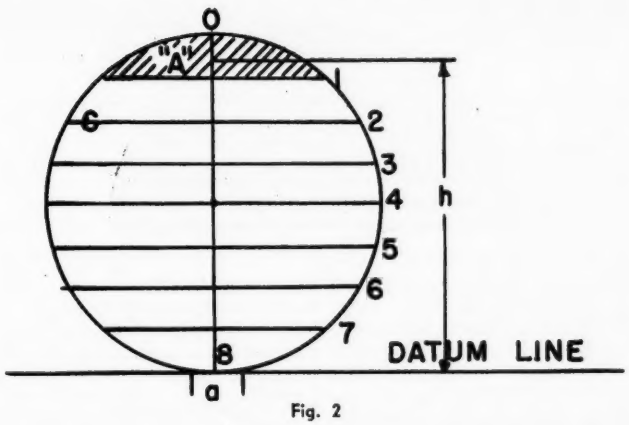


Fig. 2

As for the equalizer pipe, it is of little importance since the smaller the equalizer pipe the longer it will take the fluid to leave the vessel, and vice versa. I would use a 3 inch pipe which is ample size.

Answer No. 387

By Y. Yavitch

B. E. wishes to accomplish the process of filling in 10 min.

What are the items that he must know in order to solve his problem or answer his question?

Let us approach the question with an example from every day life.

In the case of a person that works and if we talk of his pay, there are three quantities under consideration:

1. Time—hours
2. The rate—cents
3. Amount (dollars) due

Arithmetically:

time = amount/rate
rate = amount/time
amount = rate x time

Let us assume that the person is touchy and we do not want to ask him the exact figures of the above items; we resort to generalities and we solve the problem algebraically.

We say let t = time
r = rate of pay
a = amount

then, $t=a/r$; $r=a/t$; $a=r \times t$

Note that in each case two quantities must be known, the third can be found. Now the person under consideration can take any of the algebraic equations, depending on what particular quantity he is looking for, and by putting in his own numbers get an answer without giving the specific personal information.

In B. E.'s question there are exactly the same quantities. He, however, is dealing with an amount of liquid, a certain pipe through which the liquid is flowing and the time it takes for that quantity to empty. For the moment we will ignore the fact that B. E. wishes to empty the tank in ten minutes and that the liquid is creosote. Both the time and the kind are a military secret and B. E. refuses to divulge it. It so happens that his reluctance to divulge the secret is helpful to us in answering and showing B. E. "the step-by-step method of finding these pipe sizes."

The volume of his mysterious liquid in Rueping tank we will designate by V cu ft.

The rate of flow through the opening in the tank by the capital letter Q cu ft per min. It does not have to be minutes; it can be hours, seconds. One thing, we do ask B. E. to be careful and consistent.

The time required by t minutes.

Then $t = V/Q$ minutes (a)
$V = Q \times t$ cu ft (b)
$Q = V/t$ cu ft per min (c)

The volume, V, is easy to compute. Volume, V. equals area, A, of cross-section times the length, L, of the tank.

$$V=0.7854 \times 8^2 \times 100=5025 \text{ ft}^3.$$

This is the volume of the liquid that is required to be emptied.

We are forced, for the solution of the problem, to write the volume in the form $V = 100 \times A$, since the area is changing while the tank is being emptied. The length of the tank remains constant, 100 ft.

We will now attempt to evaluate another quantity, Q, the rate of flow. To find this quantity B. E. needs the article "Flow of a Liquid Through an Opening" submitted to Power Plant Engineering by the writer. But here it is.

The rate of flow equals the area of the cross-section multiplied by the speed with which the liquid flows.

$$Q=a \times v \quad \ldots\ldots\ldots\ldots 1.$$

where "a" is the area of the cross section of the opening (pipe) in square feet. v is the velocity in ft per sec. If an 8-in pipe is used,

The area, a, is computed

$$\frac{\Pi}{4}d^2 = 0.7854 \left(\frac{8.071}{12}\right)^2 = 0.354 \text{ sq ft}$$

The velocity of the fluid is dependent on the height of the fluid from the opening as is shown in Fig. 4.

The familiar expression for the velocity of fluid caused by the "height," h, in feet.

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$$v=\sqrt{2gh} \quad \ldots\ldots\ldots\ldots 2.$$

In this expression g is acceleration due to gravity and is equal to 32.2.

Thus the velocity with which the liquid is flowing out from the tank is $8.02 \sqrt{h}$. Watch this "h." It will give us a headache.

The quantity, Q, that appears in a, b, and c, can be replaced by the expression

$$Q=8.02\, a \sqrt{h} \quad \ldots\ldots\ldots 3.$$

a is the value of the area of the pipe.

The value of Q in 3 is theoretically correct, if everything would run smooth. But there are things that alter the numerical value of Q, the rate of discharge. It is going to be less. To take care of that fact, we multiply the theoretical value by a coefficient less than unity. The exact value of the coefficient must be determined from a test of the equipment. But an approximate value can be assumed from previous experiences on similar equipment. In the case of B. E. we will accept a value of 0.61.

And the real $Q=0.61 \times 8.02\, a \sqrt{h} \ldots 4.$

Assuming that we have an 8 in. pipe, the area of the cross section is 0.354 sq ft.

And $Q=0.61 \times 8.02 \times 0.354 \sqrt{h}$
$=173 \sqrt{h} \quad \ldots\ldots\ldots\ldots 4a.$

Let's go to the ridiculous. The pay check a man brings home is less than the rate times the hours he works. There are losses, deductions, union dues, unemployment insurance, federal taxes, city tax, to mention just a few. So that to compute the amount carried home, one

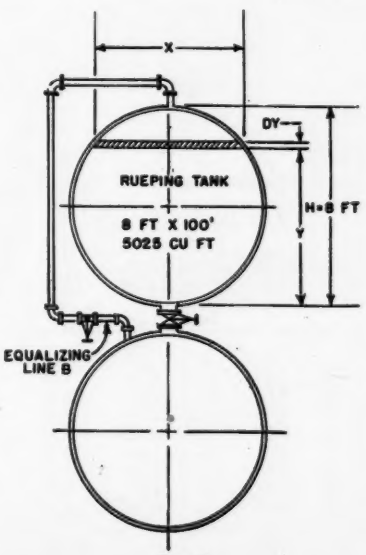

Fig. 3

PRACTICAL ENGINEER SECTION

must multiply the computed answer by a figure less than unity.

This sort of thing happens to flow. There are causes that make our theoretical answer diminish in its numerical value.

We are now ready to find the time it takes to empty the Rueping tank. We will employ $t=V/Q$ and substitute the known values that we have found so far. The volume of the tank found above $V=100 \times A$

$$t=\frac{100A}{1.73\sqrt{h}}=57.8\ A/\sqrt{h}.....5$$

Lo, and behold! We have unpleasant news. What is h? And what is A? Well, h is the height of the tank. Always? A is the area of the tank. Always? All the time? No, to solve a problem where certain values vary during a given process, we must resort to something that we practical engineers do not like. That something is known as higher mathematics. If B. E. will take our word, we shall give him an answer for the time it will take the tank to empty through an 8 in. pipe. Or the size of the pipe if the time is to be 10 minutes.

The value of $A/\sqrt{h}=2 \times 15.104=30.21$. Thus the time required to empty the tank through an 8 inch pipe equals

$$\frac{57.8 \times 30.21}{60}=29.2 \text{ minutes.}$$

To find the size of the orifice in the bottom of the Rueping tank to empty it in 10 minutes, we will resort again to the expression $t=V/Q$ using the value Q in 4.

$Q=0.61 \times 8.02 \times 0.7854\ d^2\ h=3.84d^2h$ where d is the diameter of the orifice to be found. Again

$$t=\frac{100}{3.84d^2} \times \frac{A}{\sqrt{h}}$$

$$=\frac{100}{3.84} \times \frac{30.21}{d^2}$$

$$=\frac{785}{d^2}$$

but $t=10$ min$=600$ sec.

$$\text{And } d^2=\frac{785}{600}$$

and $d=1.14 \times 12=13.7$ in.
B. E. needs a 14 inch pipe.

Table II

	A	h	$\sqrt{h}$	$A/\sqrt{h}$
1	3.70	7.5	2.74	1.38
2	6.20	6.5	2.55	2.49
3	6.30	5.5	2.35	2.64
4	8.94	4.5	2.12	1.74
5	8.94	3.5	1.87	4.77
6	6.30	2.5	1.58	4.03
7	6.20	1.5	1.23	5.04
8	3.70	.5	0.707	5.24
	50.28			27.33

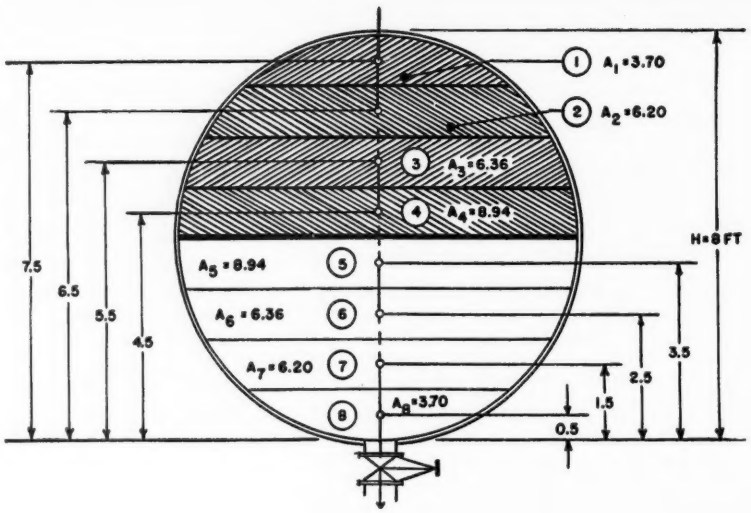

Fig. 4

In order to find the value of the expression $A/\sqrt{h}$, we must use a somewhat slow process. This is the penalty the practical engineer must take for disliking calculus.

Assume the tank to be divided into eight compartments by means of horizontal diaphragms. See Fig. 4. The total cross sectional area of 50.25 sq ft is thus divided into eight unequal areas; A1, A2, etc. Remember, unequal areas. This is the reason why expression 5 is left with symbols without a definite figure or answer.

In Fig. 4, the volume 1 in flowing through the orifice has its own velocity depending on its height, 7.5 ft. Similarly volume 2 has its own distinct velocity due to the height 6.5 ft. And so on for volumes 3, 4, and 5 etc. Adding up each individual $A/\sqrt{h}$, we get the total approximate value for that expression. The closeness of the approximation will depend on the number of divisions we make. Note that the table gives 27.33 instead of 30.21 as the value of $A/\sqrt{h}$.

The mathematician does not use a table for the addition. He "integrates," just as we multiply 6 x 3 instead of adding 3+3+3+3+3+3 to get the answer 18.

If B. E. would choose a rectangular tank instead of a circular, we would have been left with only h. But because his tank is circular, we also had to carry A for tabulation.

The equalizing pipe has no bearing on the problem. Any decent size will do. 3, 4, or 5 inch. Anything handy.

LETTERS AND COMMENTS

WHAT ARE FACTORS IN INCREASING REFRIGERATION PLANT CAPACITY WHEN POWER CAN'T BE BOUGHT?

PROPOSED EXPANSION of a meat processing plant calls for much added refrigeration capacity and power to pull this added capacity. First, purchased power cannot be considered. Due to the present power shortage, the power company refuses to take any more industrial load—a condition that is to exist, they tell us, until 1951.

The present plant consists of four refrigerating rooms;—one meat cooling room; one meat storage (these two rooms serviced by 2 3-ton direct expansion freon units); one frozen food box (1-ton unit); and one 7½-ton cold storage box. Freon is the refrigerant and a forced-air circulation system is used.

Frankly, the whole system is not too well put together. There is poor construction: for example, the doors do not fit satisfactorily. The two cooling towers are homemade atmospheric units that do their job with reasonable efficiency.

All this is powered by two 15-kw, 18.75-kva, 220-v 3-phase, 60-cycle 1200-rpm Diesel engine sets. These sets are not arranged for parallel operation. There is another 15-kw generator of the same characteristics available but not in use. All these units are portable radiation-cooled units.

The proposed expansion is this: The meat cooling rooms and cold storage rooms are to be expanded to require 75 tons of refrigeration. This will necessitate a new building

outright. It is proposed to use freon unit coolers in the various rooms, the number to depend on the needs of the rooms. It is further proposed to use two or three motor-driven compressors to handle the entire cooling load, and two generators, with 100 per cent standby, of sufficient size to pull the proposed load, which will total approximately 100 hp. Also there is to be a need of 2000 lbs of steam an hour at about 10 psi pressure.

Here are some questions on which I would like very much to have Q. & A. readers' ideas:

1. Will this forced-air circulation system be the cheapest to operate over a period of years; or should we adopt a brine spray system for the cooling room and cold storage room, or should we consider a direct-expansion unit with ammonia?

2. In the light of present-day developments, will freon be as suitable as ammonia for the refrigerant?

3. At what temperature should the cooling room be kept? The cold storage room? The frozen meat room?

4. With present day development what type of wall construction is likely to give us high insulating quality with reasonable cost? What type of ceiling and floor construction?

5. Since we will be forced to generate our own power, what type of motors will give us the lowest starting current pull to prevent oversized generators?

6. It seems to me that with this much refrigeration load, the load factor should be very high. Am I right?

7. Diesel fuel No. 1 costs 14.9 cents per gal and No. 3 is 13 cents per gal. We can get coal at about $6.50 per ton—11,500 Btu per lb.—about 10 per cent ash, etc. If we used a high-class uniflow engine, do you think this could beat a diesel?

Answers you can give will start me thinking along the right lines and then I can ask some that would be more to the point. Any information or comments will be greatly appreciated.

Mt. Vernon, Ill. A. R. E.

Must Answer Questions 3 and 4 First, Says Holman

BECAUSE THE erection of a new refrigeration plant, or the expansion of an old one, presents problems the solutions of which cannot be determined offhand by any set of rules or formulae, the questions asked by A. R. E. cannot be given specific answers. The first ideas relative to any new plant can be only general in nature. First questions must be asked about a hazy concept, which changes shape after each answer, whether or not the answer is correct or suitable. But as will be seen below, it is necessary first to answer questions 3 and 4.

Upon a basis of guesses and estimates, the first plans must be drawn. If the proposed plant is connected in any way with an existing plant or enterprise, the first outline is usually made within available space. If a new building or addition must be erected, its size and number of divisions often depends upon available funds. Within physical limitations or within economic bounds the new plant must be erected.

This is a practical and decisive point. The space to be refrigerated must first be fixed, both in size, shape and number of divisions. A large building, per cubic foot of space, is much more economical than a small one, not only to build, but also to refrigerate. Any attempt to save money by undue restrictions upon building size, or by using second class materials in its construction, is false economy.

Shape is an important factor. A square building has less exposed surface for heat absorption than a rectangular one. Shape, however, should be dictated by working conditions of the plant. If a kill of beeves, for example, must be moved from chill room to storage room to cutting room, thence to a sales room, the processing procedure may dictate the shape of building best fitted for conveyors.

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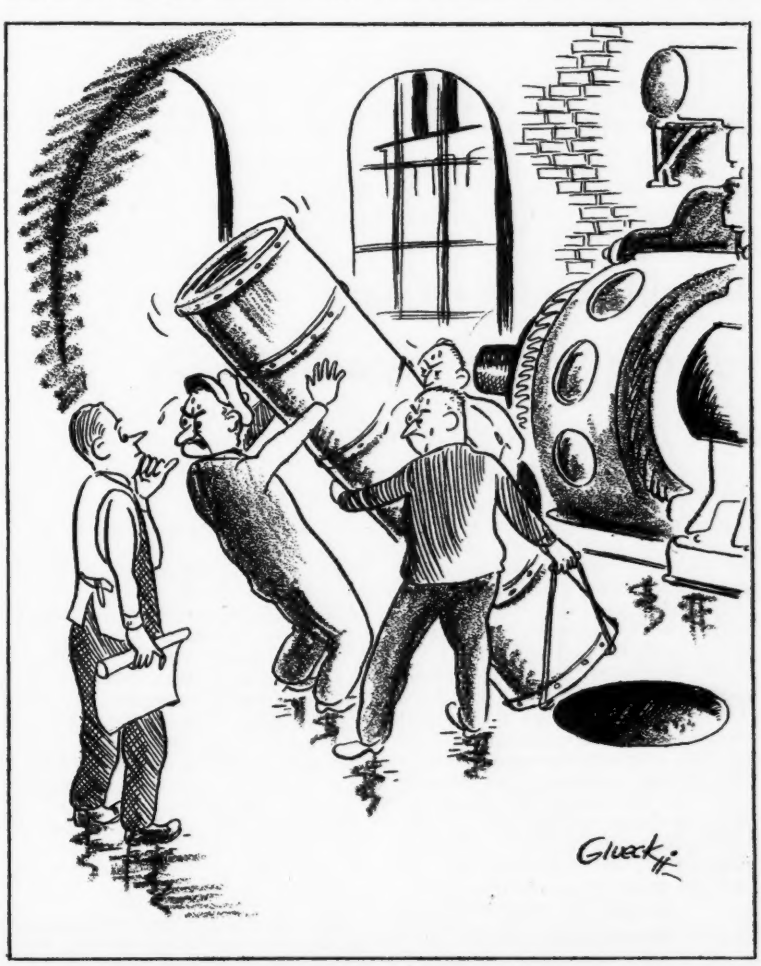
Building wall construction should be of durable and fireproof materials. Brick walls lined inside with wood, sealed with water-proof paper and then lined with corkboard make excellent heat insulating construction. Common practice is the use of 4 in. of corkboard on coolers and 6 in. on freezers.

Floors should be of concrete, covered with cork of the same thickness as used on the walls. This cork is best covered with tile or concrete of 3 in. minimum thickness.

Ceiling construction varies. If an attic space is provided, it is best filled with rock wool, or some such insulation. Any attic space should be ventilated. Hollow tile makes an excellent flat roof. This writer does



"Look, Bud, what say you shut up with that 'Easy does it' gag—."

PRACTICAL ENGINEER SECTION

not favor the water covered roof, although roof kept moist by sprinkler system reduces the amount of heat penetrating the roof on hot days. The same thickness of cork as that applied to the walls is generally sufficient for the ceiling also. The above answers Question 4.

Temperatures at which refrigerated spaces are to be kept (Question 3) depends upon the substances kept in them. This, too, must be decided upon before any of the refrigeration equipment can be properly selected. For cutting, the internal temperature of pork should be 35 F, or slightly lower. A cooling room requires much more refrigeration than a storage, or holding room. Temperature in a cooling or freezing room will vary much more widely than in a storage or holding room, unless properly controlled. If large quantities of warm goods are placed in a cooling room within very short periods, sufficient evaporator surface or circulation must be installed to meet this load. Although beef tempers well at 34 F, warm air from frequently opened doors may cause it to drip. Also, it cuts better at 30 F. Lower than this temperature, however, ice formation within the tissues may cause beef to lose its quality.

From the above, it will be seen that Questions 3 and 4 should be answered first. The proper type of refrigeration system can then be chosen to fit plant conditions.

Unless some unusual operations interfere with its use, direct expansion of ammonia is best for all large refrigeration installations. Freon has many desirable characteristics. Unless the system is kept in A-No. 1 order, however, trouble will be encountered with the compressor lubricant, ice may form at the expansion valves and the charge may be lost from the system at unnoticed leaks.

While all large electric-driven refrigerant compressors should be provided with synchronous motors, smaller ones, say 7 in. by 7 in. and smaller, may be started under load with slip-ring induction motors controlled automatically by solenoid and dashpot. Oversize generators may be avoided by the use of two smaller compressors instead of one large one of the same capacity. Load factor may be lowered by use of refrigeration storage, such as brine tanks. If possible, however, this should be avoided.

Since steam at low pressure is needed for process work, it seems that a steam engine exhausting at the pressure needed would be the more advisable to install than a Diesel. Since the exhaust steam will be used, the steam-economy of a uniflow or Corliss engine is neither necessary nor advisable. For small plants, simple machines are least troublesome; and more easily repaired, when repairs are needed.

Decatur, Ill. GEORGE HOLMAN

NEW TOOL CLEANS AND RESTORES DAMAGED THREADS

By JOHN G. REYNOLDS

THAT OLD BUGABOO of finding damaged threads on bolts and studs has been whipped to a "fare-thee-well" by a new tool that has already had its value tested and proved on many jobs in our plant. Known as a "thread cleaner", the tool cleans and quickly restores flattened, distorted or badly rusted right or left-hand threads on bolts up to 2-9/16 in. diameter. Damaged threads of any size or pitch on any type of bolt can be quickly removed and reconditioned so that nuts can be removed or put on with ease.

Operation of the tool is simple; slip the tool over the bolt, tighten the cutting jaws into the threads close to the nut and turn until the threader comes off the bolt. The tool is easily set and held to size by a single lock nut on the knurled handle.

Specific Gravity Chart for Air-Water Vapor Mixtures

By JAMES R. HALL

BY DEFINITION, specific gravity of humid air is the ratio of the density of humid air to the density of dry air at the same temperature and pressure. This item is constantly used in performance calculations of centrifugal air compressors and blowers, and a quick method of finding it is a great timesaver for the engineer performing this type of calculation.

To relieve the drudgery of numerous repetitious calculations in finding this quantity, an expression was derived and a plot of it placed adjacent to the usual psychrometric chart as shown on page 84 to give a chart expressing specific gravity as a function of the psychrometer wet and dry bulb temperatures only.

NOMENCLATURE

ρ = Density of dry air, lb per cu ft

ρ_w = Density of moist air, lb per cu ft

P = Total pressure, lb per sq ft abs

M_a = Molecular weight of dry air = 28.97

M_w = Molecular weight of water = 18.02

C = Compressibility factor

R = Gas constant, ft lb per °R

T = Absolute temperature, °R

n_a = Mols of dry air

n_w = Mols of water vapor

w = Specific humidity of humid air, lb water vapor per lb dry air

G = Specific gravity of humid air

$e = \frac{M_a}{M_w} = 1.6077$

DERIVATION

Since in most hygrometric calculations the perfect gas law is considered valid, it can be shown that for dry air

$$\rho = \frac{PM_a}{CRT} \quad (1)$$

In the case of humid air containing n_a mols of dry air and n_w mols of water vapor the density is

$$\rho_w = \frac{n_aM_a+n_wM_w}{n_a+n_w} \cdot \frac{P}{CRT} \quad (2)$$

Since $w = \frac{n_wM_w}{n_aM_a} = \frac{n_w}{n_ae}$, then

$$\rho_w = \frac{1+w}{1+ew} \cdot \frac{PM_a}{CRT} \quad (3)$$

Therefore $G = \frac{\rho_w}{\rho} =$

$$\frac{1+w}{1+ew} \cdot \frac{C(T,P,O)}{C(T,P,w)} \quad (4)$$

Within the usual limits of normal atmospheric conditions a close approximation for G can be obtained by assuming the compressibility factor ratio $C(T,P,O)/C(T,P,w)$ equal to unity which results in

$$G = \frac{1+w}{1+1.6077w} \quad (5)$$

Equation (5) is plotted adjacent to a psychrometric chart with w as the ordinate, giving the combined and final chart.

Example: Psychrometer reads wet bulb = 64° F, dry bulb = 76° F. Follow dotted line arrows and read G = 0.9940.

Questions and Answers

Answer No. 424

WHY DESIGN B. F. PUMPS FOR SAFETY VALVE BLOW?

Must Meet Maximum Possible Demand, Says Parks

A BOILER, under the conditions stated by E.R.C. in his question, would be undergoing what is called an "accumulation test." Under such conditions, a feed pump has to be able to supply the full amount of water required by the boiler. Actually, however, the average boiler feed pump has to be able to supply much more water than is required in the accumulation test or under full load.

All boilers must have, by law, two means for supplying water to them. This of course means two pumps. When both pumps are in serviceable condition, then in an emrgency, the fireman simply puts on another pump. But, one pump may be out of service or out for general repairs. Then, the full capacity of the boiler, PLUS any emergency that may arise, falls on the one pump.

The emergency conditions spoken of above may be:

(a) Tube failure: Under this condition, the pump has to supply the full load on the boiler PLUS the amount lost by the tube rupture. If the pump is not large enough to do this and the other pump is not available, the boiler is lost, unless the fire can be extinguished quickly, as with oil or pulverized coal burners.

(b) Low water: If, for any reason, a low water condition arises, the regulator is wide open and admits water at full valve opening. Under this condition, the pump has to be able to supply full load PLUS the amount required to fill the drum up to normal water level. If the pump cannot do this, then the water level cannot be brought back to normal without the services of another pump.

(c) Abnormal Overload: This condition occurs when, for example, another boiler fails while on the line. If a boiler is thrown suddenly out of service by the rupture of several tubes or complete bursting, a sudden, abnormal overload is thrown on the other boilers. This calls for extra capacity in the feed pumps. During the short period, when the load is being reduced on the plant to compensate for the loss of a boiler, an extra demand is made on the other boilers for steam. This, of course, demands extra water. The feed pumps have to be able to supply this water and *fast*. If they cannot, then boilers may be burned up.

Another condition in which the extra capacity of the pump is sometimes required is when the pump is not working properly for one reason or another; worn parts, broken parts, leakage or any other condition that may prevent the pump from delivering its full rated capacity. In this condition, the pump has to keep water in the boiler in spite of its ailment. This, of course, in modern well kept plants, seldom occurs. But it *might* occur at any time in any plant. And if a pump is worked up to its rated capacity, and some mechanical defect occurs, then it cannot keep water in the boiler at the required load.

In conclusion, a feed pump must be so designed so as to give good service under any condition that may arise. The individual feed pump need not be designed to do all of this—BUT—enough pumps must be available to do the work. Pumps must be easy starting and quickly brought in, to be effective. A boiler is not always burned up because of failure of a feed pump, because fires can be (most times) quickly put out; but the loss of production or service may be far more than the cost of installing adequate pumping facilities.

Baltimore, Md. CHAS. W. PARKS

Answer No. 425

HE WANTS DATA ON CONDENSER TUBE AND SHELL EXPANSION

IN VIEW OF the increasing tendency to install condensers with tubes expanded at both ends, said F. L. H. in the August issue, operators should be much interested in the expansion problems resulting from this method. The condenser manufacturers are, of course, fully cognizant of the problem and design their condensers accordingly. F. L. H. asked for comments, especially on the uniformity of movement of the floating tube sheet element due to differences in inlet and outlet water temperatures.

Comment by Evans

PERFORATED baffle plates are provided in most surface condensers to distribute the steam as uniformly as possible among all tubes in the tube nest.

When it becomes necessary to purchase or install replacement tubes, it is of the utmost importance that tubes be of the proper length. In curved-tube-type condensers, there are as many different lengths of tubes as there are vertical rows of tubes. To provide for expansion, the tubes are slightly bowed by locating the holes in the tube support plates higher than the corresponding holes in the tube sheets. This method is employed in condensers where both tube ends are expanded.

In straight tube condensers, the inlet ends of the tubes are usually expanded, and provisions are made for expansion of the tubes by allowing them to slide freely in the outlet side tube sheet, with provisions for the installation of a combination fibre and metallic packing between the tubes and tube sheet.

Kingsville, Md. MILTON C. EVANS

Editor's Note:—In addition to the above problems of tube, tube sheet and shell expansion in condensers, another problem, that of tube vibration, has recently been of considerable concern to operators of large surface condensers, using either bowed tubes expanded at both ends or straight tubes with one end packed. The best information we have seen on all these condenser operating problems is that contained in the reports on Turbines, Condensers and Their Auxiliaries, issued by a subcommittee of the Prime Movers Committee of the Edison Electric Institute. These may be purchased by non-members. The latest, Publication No. P-8, contains statements by operating companies on tube vibration and how they stopped or minimized it. Previous reports give data on various expansion troubles and their elimination.

Data on the fundamentals of condenser design and condenser tube and shell expansion are given in *Steam Power Stations* (3rd Ed.) by Gaffert, Chapter IV and *Steam Power Plant Auxiliaries* (2nd Ed.) by Croft, Division 8; in the publications of the condenser manufacturers; and in the proceedings of the ASME.

Answer No. 417

WHAT SUPPORTS THE WEIGHT OF THE PISTON?

IN THE June 1948 issue of POWER GENERATION these questions were raised regarding a Harrisburg uniflow horizontal engine—

(A) What is the correct piston rod clearance in its throat bushing?

(B) What is the correct vertical

setting of the rod in its crosshead?

(C) What keeps the piston from riding the bottom of its cylinder in such an engine without a tail-rod?

I am vitally interested in these questions, because the better half of our battery of steam-driven generators is now down for major contract repairs; this better half consists of a Harrisburg 480-hp engine with 23-in. bore and a long stroke, and another Harrisburg 240-hp engine with 22-in. bore and a short stroke.

The rest of our battery of generators consists of only one combination of two smaller machines of ancient vintage, so it appears that all our Harrisburg engine problems must be solved correctly and soon.

The firm doing the contract overhaul on our two engines will accept repair contracts for such Harrisburg engines anywhere in the U.S.A.

The contractor has specified a total clearance for the center (or maximum section) of the main piston in its cylinder, using the rule: "one thousandth of total clearance for each inch of piston diameter."

An important aspect of these pistons is that they are somewhat barrel shaped, being tapered at both ends.

Now as to E.A.N.'s specific questions:

Answer (A)—The contractor expects to give us a total throat clearance "slightly more than double the specified vertical piston clearance." This neck bushing will not become a bearing or a guide before considerable wear on the piston or the cylinder has occurred.

Answer (B)—The position of the rod in the crosshead should be on dead center between the vertical guides; or raised somewhat to provide for future slipper wear. This amount of provision for wear should not exceed one thousandth of the radius of the guides.

Answer (C)—(1) Nothing—When turning the engine with the Armstrong jacking gear nothing keeps the piston from riding the bottom of its cylinder; inject oil before jacking.

(2) When operating at speed: Nothing, except three tendencies, prevents the piston from riding. Those three are:

(a) Both ends of the piston are concave: the steam pressure tends to center the piston.

(b) The tendency of the rod to remain rigid at top speed if given the proper chance (or alignment).

(c) The further tendency of the piston to follow the alignment of the cylinder and the alignment of the guides. Both alignments must be identical.

In conclusion, the writer has never heard of a piston ring being made to help lift or position a horizontal piston.

The three tendencies under C2 should combine to keep the effective weight and friction of the piston, which is riding its cylinder, down to such a minimum as to cause only a reasonable amount of wear; this wear should be measured with inside micrometers at least semi-annually.

The Harrisburg Uniflow Engine Co. is out of business, with no successor for the manufacture of their design of horizontal engines. There is plenty of opinion that they might have remained in such manufacture if they had provided their larger pistons with suitable weight-carrying tailrods.

Some of their pistons approach 30 in. in diameter, weigh a thousand pounds and have a distance of more than 4 ft of 3½ in. rod between the assembled piston and crosshead, while having a stroke of 25 in.

It was evidently impossible to combine a suitable tailrod with their distinctive type of hollow cylinder head.

Maywood, N.J. FRANK SOUTHWORTH

Answer No. 426

SHOULD HE REMODEL THIS POWER PLANT OR BUILD A NEW ONE?

AS A RESULT OF the present and projected expansion plans of a small college, its engineer, V.A.C., wants Q & A readers comments on what he can do to keep his power plant in step with the demands.

In the August issue, he described in detail his power plant, containing three old water-tube boilers fired by pneumatic spreader stokers and three 150-kw steam-engine-driven generators, all 220 v d-c. After discussing his present and expected electric and steam loads, he asked if a-c or d-c would be recommended, and asked what would be the most economical modern equipment for serving the increasing load?

We naturally recommended a consulting engineer, who would earn his fee out of the savings he could make in working out this problem. The following comments agree and give additional data to guide V.A.C. One raises some very pertinent questions about the load figures given in August. But there is no question that much more information would be needed for effective help.

Factors in Steam and Electric Costs, and much more, discussed by Darnell

WE CONCUR in the statement in the editor's footnote, that this is a problem for a consulting engineer. Obviously the consultant will need to visit the plant site and obtain many answers not given by V.A.C.

Disregarding for the moment the question of whether a-c or d-c generation should be installed, the first question that comes to mind is: Why is the faculty being denied "many electrical conveniences that are very helpful in their work" if the present generator capacity is 450 kw whereas the average demand is only 193 kw? Furthermore, there appears to be discrepancy in the statement that the high point in the demand was 800 amp per hr and the "average" demand is 193 kw. If the voltage is 220, then 800 amp will give a peak demand of only 176 kw.

If the new buildings will add a load of 290 kw per hr in excess of the capacity of the present generators, it may be more economical to buy the additional power for the new buildings or junk all the old equipment and buy *all* the power needed. This, of course, presents the problem of whether the local power company can supply all or part of the power needed. Unexpected growth of many communities has placed unprecedented demands on power companies and many are unable to take on extra loads. Also, even if the power company can absorb the load, since it would supply only a-c, all the present motor-driven appliances in the college would have to be scrapped. However, it might be cheaper to do this rather than continue to use d-c. Finally, V.A.C. has not told us his average cost for generating power.

There is a further discrepancy to be found in the steam demand figures. Adding 18,800 to 28,300 lb, we obtain 47,100 lb as the present load. Considering the V.A.C. says they have two old 200-hp and one 150-hp boilers, which probably cannot exceed 200 per cent rating if operated continually, there is a large question as to how these boilers can meet his load. With 550 boiler hp at rated capacity and assuming 30 lb per hp, we obtain 16,500 lb at rated capacity. Dividing 47,100 lb by the latter figure we obtain 287 per cent for the per cent of rated capacity at which these boilers must operate to produce the maximum steam load. It seems doubtful that they are capable of such operation.

V.A.C. has not told us the water rate of the three engines, so we don't know their steam load, nor whether it is included in the present value of 18,800 lb given as "Diversified Demand."

Even if the local power company can take all of the electrical load, the total estimated future heating load of 43,100 lb per hr will require the present boilers to operate at approximately 290 per cent rafting continuously. This means that probably the old boilers should be scrapped and two or three larger boilers installed. This question, however, depends in part on present steam cost, concerning which V.A.C. has not given us any information. Steam and electric costs are only a small part

of the many items to be studied before we can decide whether to remodel the present power plant, build a new one, or buy power and furnish steam only for heating.

The subject of heating with steam is alone a complicated problem, particularly where many buildings are involved. What is the most economical pressure at the boilers? What type of appliances, direct radiation, speed heaters, unit ventilators, or finned surface in air ducts? These and many other questions must be asked and answers obtained before the problem which V.A.C. presents can be solved.

Dallas, Texas — J. R. DARNELL

Gray Cites Cases of Plant Expanion

I AM IN complete agreement with the editor's note on hiring a consulting engineer to work out V.A.C.'s problems. However, as you asked for comments, I would point out some instances of power plant expansion:

R. H. Macy Department Store and office buildings

Formerly coal fired. Now fired by mechanical No. 6 Petro oil burners under a battery of B & W water-tube boilers. Original and part of present plant—Rice and Sargent tandem-compound Corliss engines, designed to run condensing or non-condensing. Other prime movers—Mixed-pressure turbine connected to engine exhaust and live steam. Two eight-cylinder Diesel engines. All these had driven three-wire, d-c. 250-v generators (D-C was used because batteries for electric driven autos were charged part of the 24-hr day.) A unique feature was the economizers hung over the controlled feed incinerators so that water pumped through them to the boilers was maintained within one degree of 250 F.

Refrigerating equipment for air conditioning—Driven by Terry low-pressure turbines. Refrigerating equipment for ice making—Driven by electric motors.

Another similar plant—Museum of Natural History

Water-tube boilers fired by Coxe chain-grate stokers, burning run-of-mine and supplying steam to Hamilton Corliss tandem and single engine generator sets, of three-wire 250-v d.c. type, and with balancer sets.

My choice in V.A.C.'s case would be three-phase a.c., a synchronous motor to maintain good power factory, small return pumps for condensate in the outermost buildings driven by synchronous motors, power generation by uniflow engines (or installation of uniflow cylinders on existing equipment); Diesel engine or engines for night or standby service; good steam generators of water-wall or bent-tube type fired by the handiest, most economical fuel.

New York — EDWARD W. GRAY

Answer No. 432

HOW CALCULATE CENTRIFUGAL REFRIGERATING COMPRESSOR TONNAGE?

IN THE November issue, J. T. gave all the data on his centrifugal refrigerating compressor, including the water inlet and outlet temperatures, and asked how to calculate the tonnage. Here's the way to do it.

Calculation of Tonnage

The exact answer to the question of how to calculate centrifugal refrigerating compressor tonnage is this: Since we know that a removal of 200 Btu per minute is equivalent to 1 ton of refrigeration (by definition), then if we knew the total Btu removed or transferred, we could find the tonnage. But the cooling water temperatures are given, so we can figure the Btu removed in the cooling water. Hence: Tons of Refrigeration = (Rise × gpm × 8.33) ÷ 200 where gpm is *actual* gallons per minute of water flowing. Rise is actual temperature difference between inlet and outlet water (in degrees F) on the water cooler.

Example:

Assuming 670 gpm of water flowing

Rise = 48 — 40 = 8 F

Tons = (8 × 670 × 8.33) ÷ 200 = 223

The unit described is one of the old style units using methylene-chloride or carrene No. 1, as a refrigerant. These units have not been on the market since 1934.

Syracuse, N.Y. — C. T. SHIELDS

Answer No. 433

DO COAL-FREEZING PREVENTIVES CORRODE COAL-HANDLING AND BURNING EQUIPMENT?

THIS QUESTION, asked in the November issue by F.M.R., is particularly timely because of the approach of winter when many plants will be having trouble with frozen coal cars. Problems of coal buying and coal quality were reviewed by Julian E. Tobey in the August issue; and a discussion of freezeproofing treatments for coal and of the various thermal and mechanical methods of handling frozen coal was presented in the September issue.

Because many companies are buying coal that has been treated by the coal suppliers with various chemicals to prevent freezing during transit, power engineers often wonder whether or not these chemicals have any serious corrosive effects on the equipment that handles the coal in their power plants. We receive many inquiries about this, of which F.M.R.'s is typical.

One engineer with wide experience in treating coal at the mine and handling it during transit and into the plant, comments as follows:

"I personally know of no serious corrosive effect of a practical nature resulting from the proper use of calcium chloride in cases where the producer of coal has either thermally or mechanically dewatered the coal preliminary to loading.

"Where the washed coal has not been adequately dried before loading and, to prevent the coal freezing in the cars, complete reliance is placed on calcium chloride, corrosion trouble would quite likely result.

"In all cases, I personally would recommend refraining from the use of rock salt."

Julian E. Tobey, now with Appalachian Coals, Inc. offers the following comment.

A short time ago, Bituminous Coal Research, Inc. at Battelle Memorial Institute, and the University of West Virginia, made extended tests on the corrosive effects of calcium chloride, which is used for freeze-proofing, and also in at least one system of heavy media separation or washing.

Information Bulletin No. 5 of Bituminous Coal Research, Inc., treats the matter of corrosion from calcium chloride at some length. (Bulletin No. 5 is entitled The Dustless Treatment of Coals with Calcium Chloride and Other Materials, by Ralph A. Sherman and George W. Land). Briefly, the conclusions reached are these:

(1) There is no acid reaction from calcium chloride at normal temperatures, although it may happen in cases where the solution is subjected to heat for long intervals. If conditions are bad, this can happen in domestic stoker screws; but it is not likely to happen in commercial or industrial equipment.

(2) Water will react with iron at normal temperatures to form iron oxide, or rust. The reaction is electrolytic and complex. Any "salt" or other material that will form an electrolyte helps this reaction to some extent. Thus, calcium chloride is corrosive in that it acts as an electrolyte, as do a number of other substances. Since wet coal will react without it, there is a big question as to how much corrosion to attribute to calcium chloride. In an inside bunker where heat from the boilers dries the coal, or where the metal is swept clean by coal movements, there is likely to be very little.

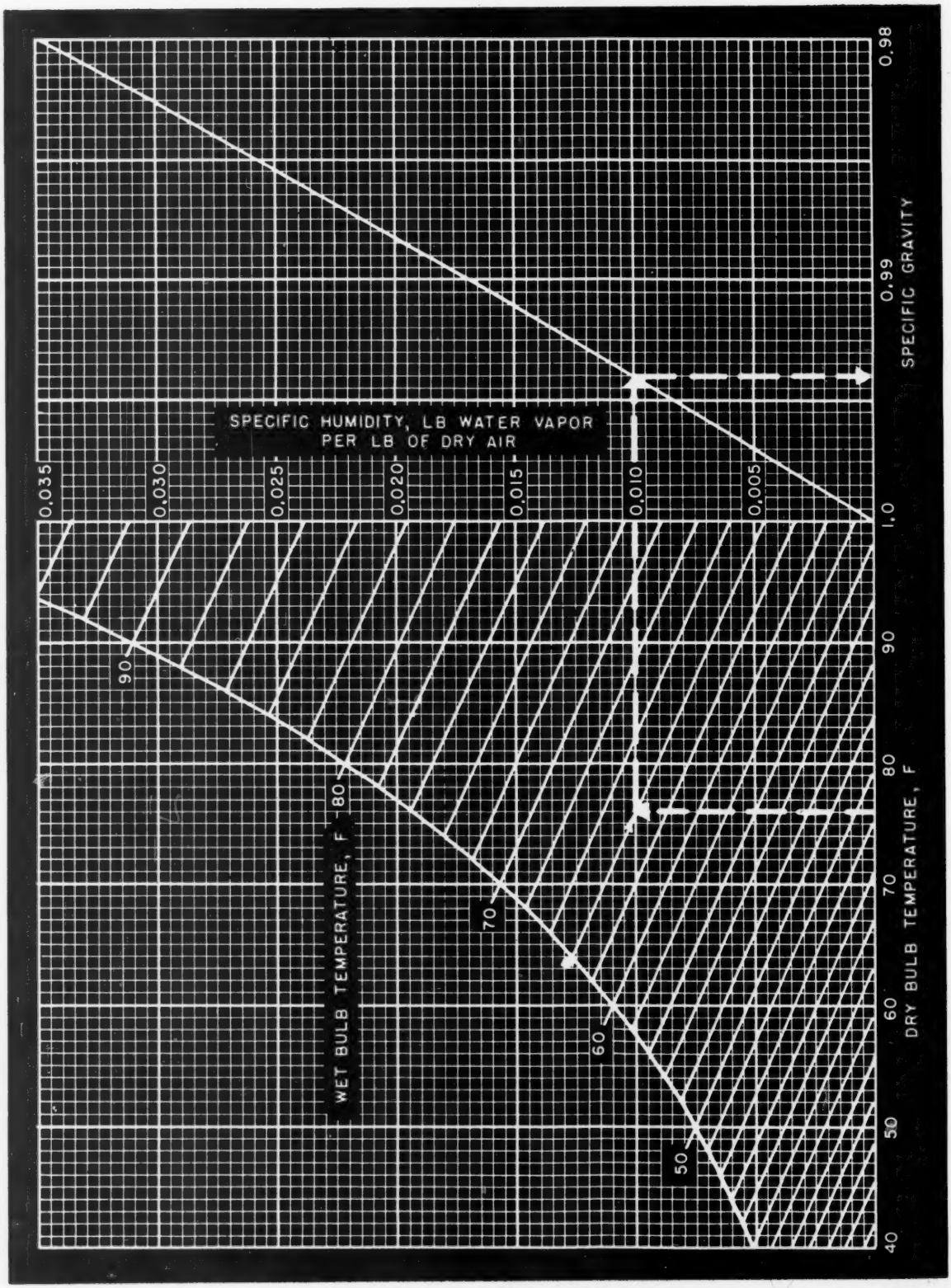
(3) Rusting and wear will take place anyhow; so it becomes a question of which is the worse—the chance of some additional corrosion at times, or frozen coal? In most parts of the north, coal needs to be freeze-proofed only about four months per year.

A close study of the economics of this problem would probably reveal that the elimination of extra labor to unload frozen coal would pay for any extra corrosion with a comfortable margin to spare.

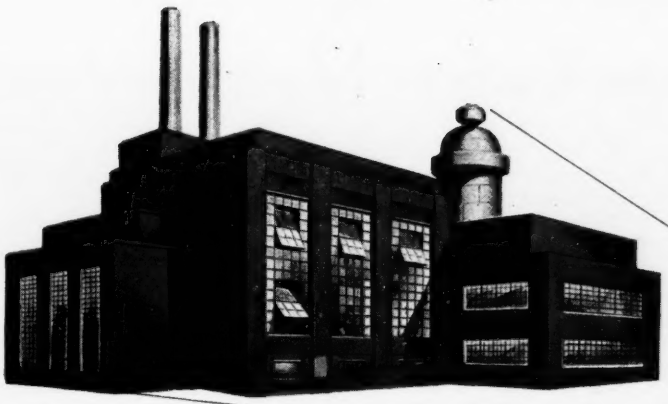
PRACTICAL ENGINEER SECTION

Air Water Vapor Specific Gravity Chart

(See page 80)



As explained on page 80 this chart expresses specific gravity as a function of the psychrometer wet and dry bulb temperatures



Then there's the rule of *Thumb* method

. . . when scientific knowledge is replaced by instinct.

It's a good rule to follow for some things, but totally inadequate for *efficient* boiler plant operation.

Correct water conditioning, for instance, is a matter of careful and scientific control.

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Shunts and Inductors for Surge Current Measurement

IN RECENT YEARS improvement in the design of electric power systems and their component parts, such as transformers, circuit breakers, lightning arrestors, etc., have reduced power failures from lightning to a small but still annoying number. These new developments have been made possible by the use of surge generators, which enable man to produce in the laboratory, electrical surges having the same voltage and current magnitudes as those occurring on transmission lines as a result of natural lightning. Technique in this field has advanced to a point that most manufacturers of high voltage equipment now maintain high voltage and high current surge generators, and measuring equipment in their laboratories both for development testing of insulation design and for routine tests on equipment for high voltage networks.

In order that data thus obtained may be used to best advantage in the overall design of a power system, surge measurement methods must give equivalent results in all surge testing laboratories, and should provide as accurate a picture as possible for the actual surge, however, the satisfactory measurement of surge current presents peculiar difficulties because of the high values of impulse currents. Currents up to two hundred thousand amperes attained in a matter of a millionth of a second.

The National Bureau of Standards is, therefore, seeking to develop better methods of surge measurements and to assist in the standardization of surge testing. An important phase of the work conducted by John H. Park of the Electrical Instrument Laboratory has been the development of shunts and mutual inductors for measuring the magnitude and rate of change of surge current.

High current surges are obtained by discharging a bank of capacitors previously charged to a high potential through a low impedance path consisting of the test specimen and the measuring equipment. They are usually measured by inserting a low resistant shunt in the discharged circuit and applying the voltage drop across this shunt to a high speed cathode ray oscillograph, which gives a record of the wave shape and magnitude of the voltage drop. For this measurement to be capable of simple interpretation in terms of current, the voltage drop across the shunt must be proportional to the current through it, and the proportionality factor must be the same for various parts of current surges and for all values of current during the surge. This requires the shunt to have (1) Low residual inductance (2) Minimum inductive pickup from stray magnetic field (3) Sufficient mass to absorb the heat energy developed in it during the surge without a temperature rise that would affect its resistance, dimensions, and strength (4) Sufficient mechanical strength to withstand the deformation by forces associated with the magnetic field of the large momentary current (5) Negligible skin effects for frequencies up to several megacycles per second.

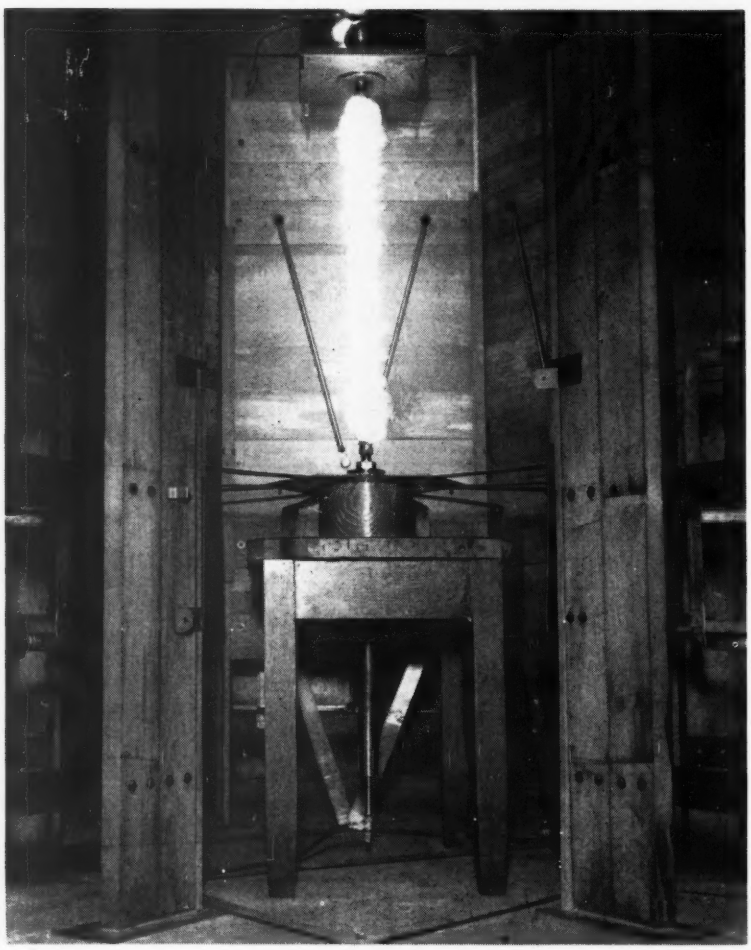

Fig. 1. A 100,000 amp current surge is measured during discharge by means of a coaxial tubular shunt (beneath the table) developed at the Bureau of Standards. The current magnitude is determined from the characteristics of the voltage drop across the shunt as recorded on a high speed cathode ray oscillograph

After a rather complete theoretical comparison of the various types of shunts that might fulfill these requirements, it was concluded that a shunt consisting of two coaxial tubes with the potential measuring circuit brought out as a coaxial cable from the smaller tube would be the most satisfactory for surge current measurements. Two shunts of this type have been constructed and used at the Bureau of Standards. One of these was the coaxial tubular form and the other flat strip type. Both of these types of shunts lend themselves well to computations of inductance and skin effects. The advantages of the coaxial tubular shunt include a more nearly con-

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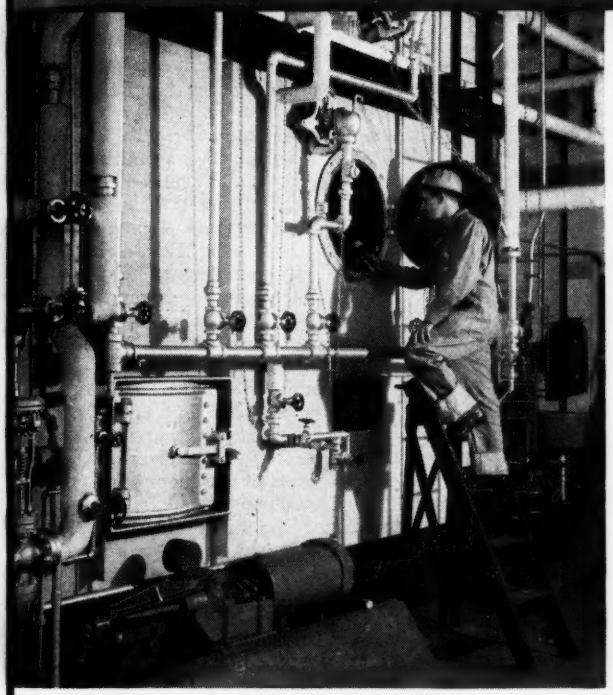

Dowell engineer checking boiler temperature with a pyrometer during chemical cleaning.

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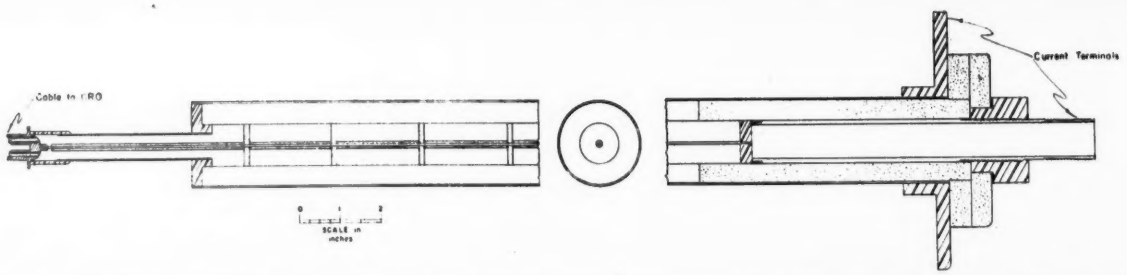


Fig. 2. The resistance element of the coaxial tubular shunt is a resistance tube connected to a cathode-ray oscillograph by means of a coaxial cable. Uniform distribution of the current in the shunt is insured by the coaxial arrangement and by extending the tubular current leads several diameters beyond their junctions with the cathode-ray oscillograph (CRO) leads. This particular shunt is designed for currents of from 50,000 to 200,000 amp, and smaller shunts are used for currents below 50,000 amp

stant impedance over a wide frequency range, minimum inductive pickup from current carrying parts of the surge generator, and freedom in location of ground connections at the surge generator.

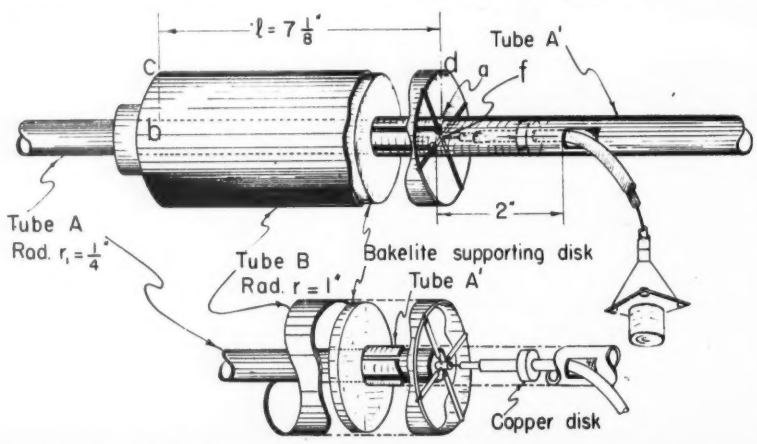
The tubular shunt was found to have a much lower time constant than the flat strip indicating that its reactance would be negligible over a higher frequency range. The skin effect at one megacycle was apparently the same for both shunts, but the formula used in obtaining the skin effects for the strip shunt neglected edge effect which is known to increase the skin effect considerably at higher frequencies. It appeared that the tubular shunt, since it has no edge effect, would have less change in effect of impedance at high frequencies than the strip shunt. The analysis showed that a decrease in both inductance and skin effect could be obtained by going through thinner strips or thinner wall tubes, but that this procedure could not be carried too far because of the heat capacity requirement of the shunt. In any case, an improvement made by this means in the strip shunt could probably also be made in the tubular shunt.

Experiments showed that the rate of change of current in the discharge circuit of the surge generator at the Bureau of Standards, may be as great as 5×10^{10} amperes per second, in which case a very small pickup loop in the potential measuring circuit might easily have sufficient mutual inductance to induce an electromotive force of more than 100 volts in the potential circuit. The extreme importance of minimizing mutual inductance between the potential circuit and all carrying current parts is thus apparent.

The potential circuit of a tubular shunt may be considered as an extension of the coaxial cable from the cathode ray oscillograph, ending in a direct short circuit from the central conductor to the sheath. Because of axial symmetry of this arrangement, the mutual inductance between the potential circuit and any current carrying parts is the lowest that can be obtained.

Another important phase of the work done in this field at the Bureau of Standards is the use of the mutual inductor for the measurement of high rates of current change. In many experiments involving high current surges it is desirable to know at what rate the current changes with time. In the use of a mutual inductor for this purpose the primary of the mutual inductor is connected in the heavy current discharge circuit, and its secondary is connected to the oscilloscope. The voltage record obtained on the oscilloscope is then a function of the rate at which the current is changing and of the known mutual inductance of the inductor. To be suitable for this purpose a mutual inductor must have a low mutual inductance, (about 0.05 microhenry) computable from its dimensions and its effective inductance should be constant for frequencies up to 50 megacycles per second or higher.

Since no previously known design of mutual inductors would fulfill these requirements, a coaxial tubular mutual inductor was designed at the Bureau and a 0.05 microhenry inductor of this design was constructed. Essentially it consists of two coaxial tubes of conducting material connected by a radial conduction ring. The inner tube constitutes the primary of the mutual inductor, and the secondary consists of the shorter outer tube, the portion of the inner tube within the outer tube and the connecting ring as in the case of the shunt, the coaxial tubular construction tends to minimize inductive pick-up from any magnetic fields that may be present. This type of inductor should also prove useful in other applications requiring measurements at high frequencies.



Details of the mutual inductor developed by the Bureau of Standards for measurement of high rates of current change

FREE COLD

INSULATION OF the refrigerator will keep cold out of the enclosed space as well as in. Refrigerator cars bound East from California have been shutting out possible sources of coolness on the mountain routes. Experiments have shown that the free cold may be used to advantage, so regulations have been relaxed to permit this saving. Incidentally, iced refrigerator cars may sometime be obsolete as a dodo. Research with a car supplied with compressed ammonia at intervals, for cooling like that in the gas refrigerator, has been successful; if applied to all cars this method would reduce the number of stops markedly, speed up the fruit trains. *Science and Appliance—OSU Research Foundation.*

Ready power for the PETROLEUM INDUSTRY with WICKES TYPE-A water tube boiler

Designed for efficient steam generation, Wickes Type-A water tube boilers are now in use in the nation's leading oil refineries. Three proved advantages make this Wickes unit *the most efficient of its type:* 1) — It has twice the black surface of the average boiler; 2) — Combustion gases travel through staggered rows of tubes, assuring high operating efficiency under varying load conditions; 3) — Two simple U-tubes with no excessive resistance, *insure positive water circulation* necessary to high heat absorption. • Wickes Type-A Water Tube Boilers are made in capacities to 200,000 lbs. steam per hour, with pressures up to 850 lbs. psi. Drums welded to A.S.M.E. standards. *Write for descriptive catalogue.*

THE WICKES BOILER CO.

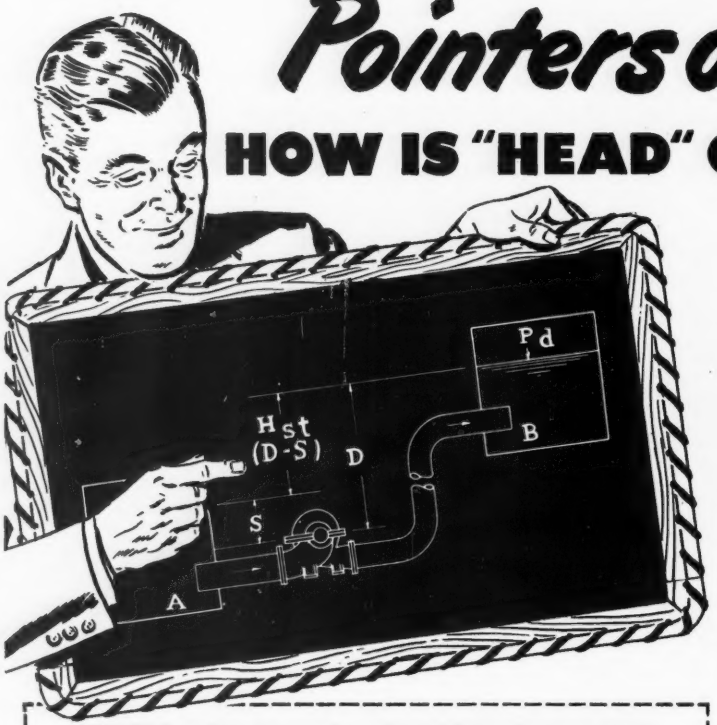
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cincinnati • Denver • Detroit • Houston Indianapolis • Kansas City • Los Angeles • Milwaukee • New York City • Pittsburgh • San Francisco San Jose • Seattle • St. Louis • Tulsa • Saginaw • Mexico City • Buenos Aires.

RECOGNIZED QUALITY SINCE 1854

Pointers on Pumps

HOW IS "HEAD" CALCULATED?



The total head of a centrifugal pump is the energy it imparts to the liquid, and is determined by finding the difference between discharge head and suction head. Thus, as a suction lift is a negative suction head, the total head is the sum of the discharge head and the suction lift.

If the discharge head and the suction head are not determined independently, the total head can be calculated by determining the algebraic sum of (1) the static head from supply level to discharge level, (2) all friction losses for the capacity considered, (3) entrance and exit losses and, (4) terminal pressure minus suction supply pressure. For complex systems involving both vacuums and pressures it is often easier to convert these factors into absolute pressure values, expressed in feet of the liquid handled.

When measured by gages at the pump's suction and discharge opening, the total head is the discharge head minus the suction head. Discharge head is the sum of the discharge gage reading, corrected to the pump center line, and the velocity head at the point of the gage's attachment. Suction head is found by applying the same formula to the suction gage reading. Since it is easy to get the plus and minus signs of the various elements reversed, and because of the many precautions necessary in taking gage readings, it is advisable to follow the instructions in the Test Code of the Hydraulic Institute.

The diagram shows the heads involved in calculating suction head, discharge head, total head and NPSH. (The term "NPSH" was discussed in a previous advertisement in this series. Reprints are available on request.)

NOMENCLATURE OF HEADS NOT SHOWN ON DIAGRAM

h_{fs} = friction head loss in suction line

h_{fd} = friction head loss in discharge line

h_f = total friction head loss from A to B

*h_i entrance loss at A

*h_e = exit loss at B

P_{vp} = vapor pressure of liquid at pumping temperature

All heads and pressures must be expressed in feet of liquid with proper algebraic signs. Pressures P_s, P_d and P_{vp} can be either in gage or absolute values but, in any case, must all be measured above the same datum.

*Some engineers include these losses in h_{fs} and h_{fd}.

$$\text{SUCTION HEAD} \quad h_s = S - h_{fs} - h_i + P_s$$

$$\text{DISCHARGE HEAD} \quad h_d = D + h_{fd} + h_e + P_d$$

$$\text{TOTAL HEAD} \quad H = h_d - h_s$$

$$= H_{st} + h_f + h_i + h_e + (P_d - P_s)$$

$$\text{NPSH} \quad = S - h_{fs} - h_i + P_s - P_{vp}$$

(To convert pressures in psi to feet of liquid, multiply by 2.31 and divide by specific gravity of the liquid at pumping temperature.)

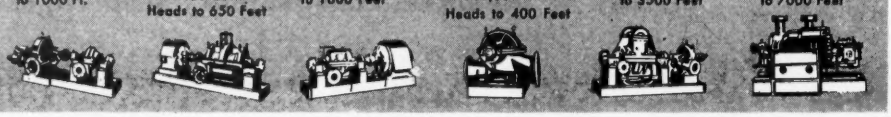
Worthington's Complete Line

of centrifugal pumps includes all pressures and capacities. For expert advice on any pumping problem — and further details proving *there's more worth in Worthington* — contact our nearest District Office. Or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, New Jersey.*

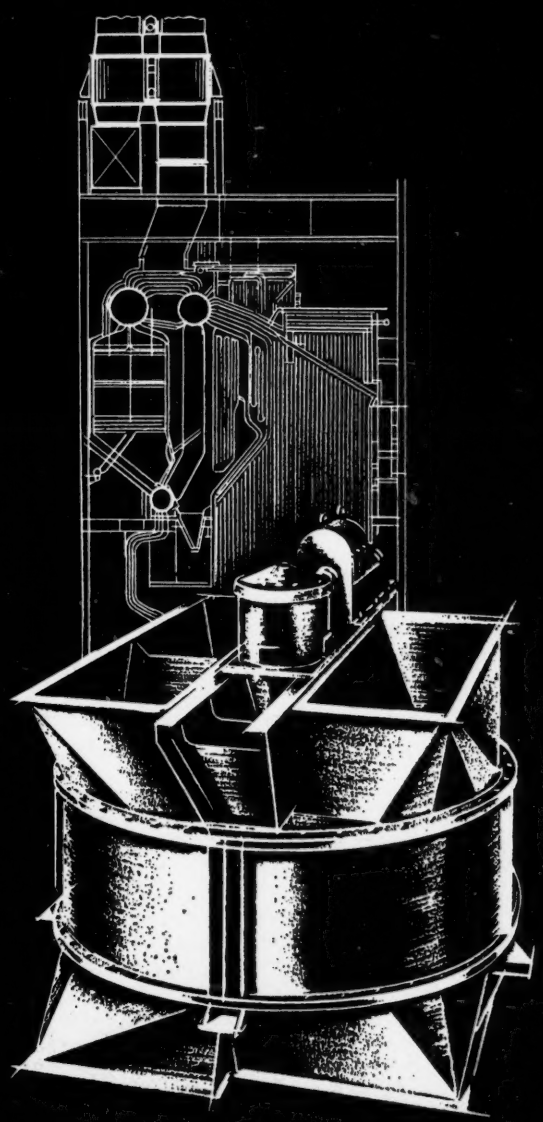
C8-10

WORTHINGTON

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB


For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1000 Ft.
For Hotwell, Condensate, Chilled Water Service
Capacities to 1400 GPM
Heads to 650 Feet
For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1600 Feet
For Water Works, Circulation, Drainage, General Service
Capacities to 135,000 GPM
Heads to 400 Feet
For Boiler Feed Service
Capacities to 1600 GPM
Heads to 3500 Feet
For Boiler Feed Service
Capacities to 3000 GPM
Heads to 7000 Feet

Designed for Preheat where fuel is a problem



The Ljungstrom Air Preheater simplifies the problem of burning such fuel as oil, low-grade coal, bagasse or paper-mill refuse.

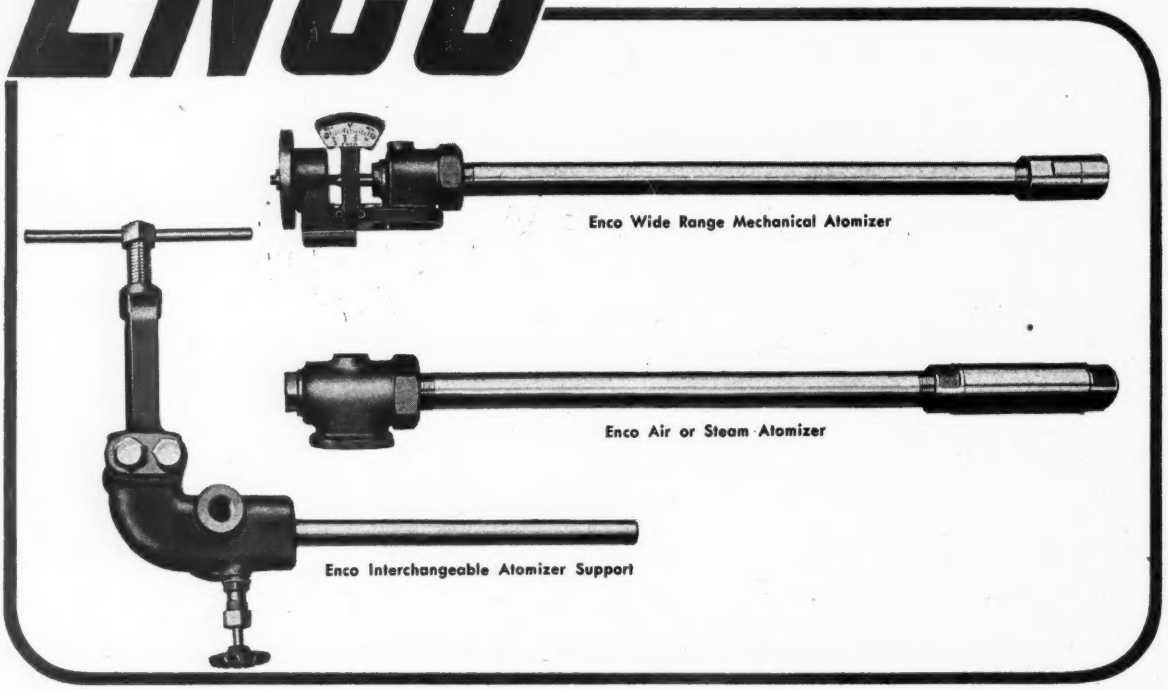
While plans for steam generation plants are under consideration, investigate the possibilities of the Ljungstrom. The specialized experience of Air Preheater engineers is at your disposal, to aid in effecting the most economic heat recovery from flue gases.

The Air Preheater Corporation

EXECUTIVE OFFICES: 60 East 42nd Street, New York 17, N. Y. • PLANT: Wellsville, N. Y.

For Better Combustion Practice Use

ENCO INTERCHANGEABLE ATOMIZERS



Interchangeable Enco Fuel Oil Atomizers are improving combustion practice in more and more progressive boiler rooms. Designed for exceptionally wide capacity ranges with all grades of liquid fuels, they eliminate burner tip changes, through the entire load range.

1. *Wide Range Mechanical Atomizers*—With a capacity range of 10 to 1—controlled manually at atomizer or automatically from remote station—*constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.*
2. *Steam or Air Atomizers*—Capacity range of 10 to 1—controlled by manual or automatic pressure regulation.

Both atomizers are designed to fit the Enco Interchangeable Atomizer Support. Enco Straight Mechanical Atomizers are also available.

Enco Fuel Oil Atomizers are built to give most economical, efficient service for any type pulverized coal, gas or oil-burning air register as well as for stoker-fired and industrial type furnaces. They can also be used independently for special applications.

The Engineer Company maintains a research and planning staff to help you improve your combustion practice. Literature completely describing any Enco product will be sent on request.

EC-473

THE ENGINEER COMPANY
ALSO PRODUCES:
Enco Air Registers
Enco Fuel Oil Pumping and Heating Units
Enco Automatic Oil-Electric Ignition Systems
Enco Automatic Combustion Controls
Enco Streamline Baffles

THE ENGINEER COMPANY

75 West Street, New York 6, N. Y.

Canadian Representative:
F. J. Raskin, Inc.
4220 Iberville St., Montreal 34, P. Q.

by engineers for engineers

ENGINEERS design and supervise every step in the manufacture of WeldELLS and Taylor Forge Flanges to meet the most exacting requirements of the most exacting customer.

Taylor Forge engineers have spent a good many years meeting special needs for unusual piping installations around the world and in every basic industrial field.

This is an important reason why engineers in thousands of companies turn to Taylor Forge when their problems are tough.

It is an important reason for *you* to turn to Taylor Forge for the finest welding fittings and flanges.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS General Offices & Works: Chicago 90, Ill. (P.O. Box 485) Eastern Plant: Carnegie, Pa. Western Plant: Fontana, Calif. • District Offices—New York: 50 Church Street • Philadelphia: Broad Street Station Bldg. • Pittsburgh: First National Bank Bldg. • Chicago District Sales: 208 S. LaSalle Street • Houston: City National Bank Bldg. • Los Angeles: Subway Terminal Bldg.

Make the layout justify the outlay
Whatever your piping problem, "Corrosion Service Piping" will help you do a better job. Write for your copy.

Send me "Corrosion Service Piping"

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Company_____

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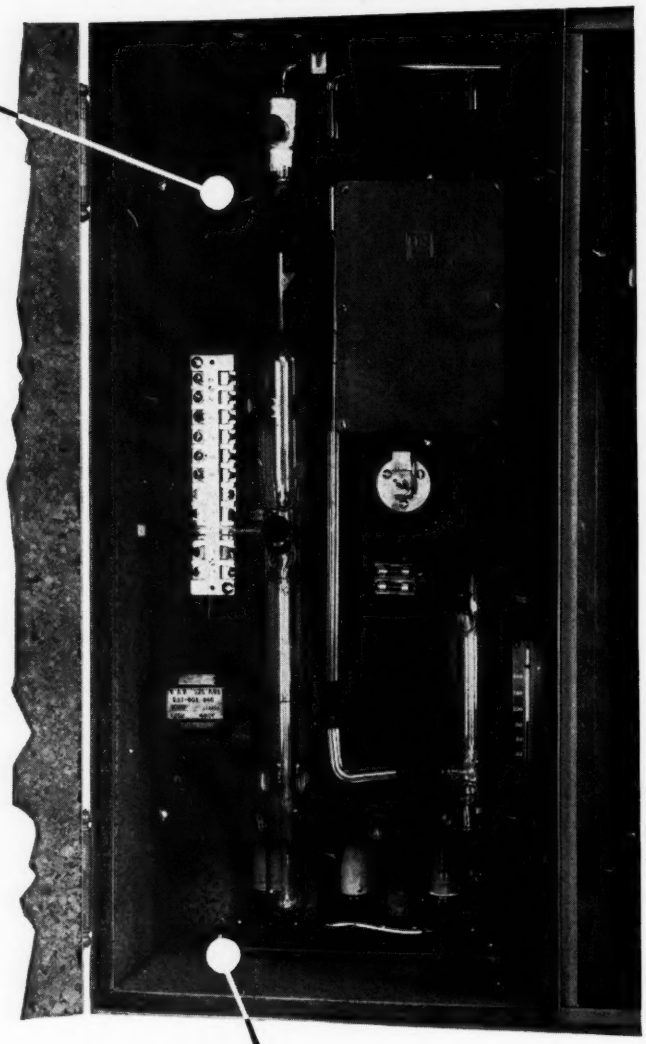
Mail to Taylor Forge & Pipe Works
P. O. Box 485, Chicago 90, Illinois

"Backing up" MICROMAX CO_2 Recording Equipment

(*Photograph courtesy of Leeds & Northrup Co.*)



K&M EBONIZED ASBESTOS

Electrical Mounting Material

The Micromax CO_2 Equipment for flue gas analysis manufactured by Leeds & Northrup Company . . . is a precision industrial unit that accurately detects and records per cent carbon dioxide . . . enabling combustion efficiency to be held at a high level. For added safety and efficiency the components of the CO_2 analysis cell are mounted on K&M Ebonized Asbestos.

More and more engineers are specifying K&M Ebonized Asbestos dielectric mounting material . . . and here are *six reasons why:*

1. Unusually strong—both dielectrically and mechanically.
2. Highly resistant to shock, vibration, temperature changes.
3. Uniform density throughout.
4. Easy to machine, cut, drill and handle.
5. Versatile in use—supplied in various thicknesses up to 4".
6. Neat, efficient appearance in finished units.

Ebonized Asbestos is a tough, dense sheet of moulded asbestos fibers, Portland cement and an insulating compound. It meets the technical requirements of Underwriters' Laboratories . . . and will satisfy your requirements in switchboards, bus bar runs, compartment linings, testing tables, bench boards. Write us for more details.

Nature made Asbestos . . .

Keasbey & Mattison has made it serve mankind since 1873

KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

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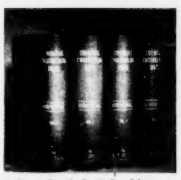
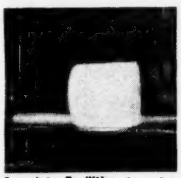
DIAMOND ANNIVERSARY 1873 K&M 1948 KEASBEY & MATTISON CO.

Metallurgical Research conducted continually by recognized specialists who have made major contributions in this field.



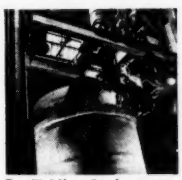
Unique Technical Backing of an extensive organization with an international reputation in both process and fabrication engineering.



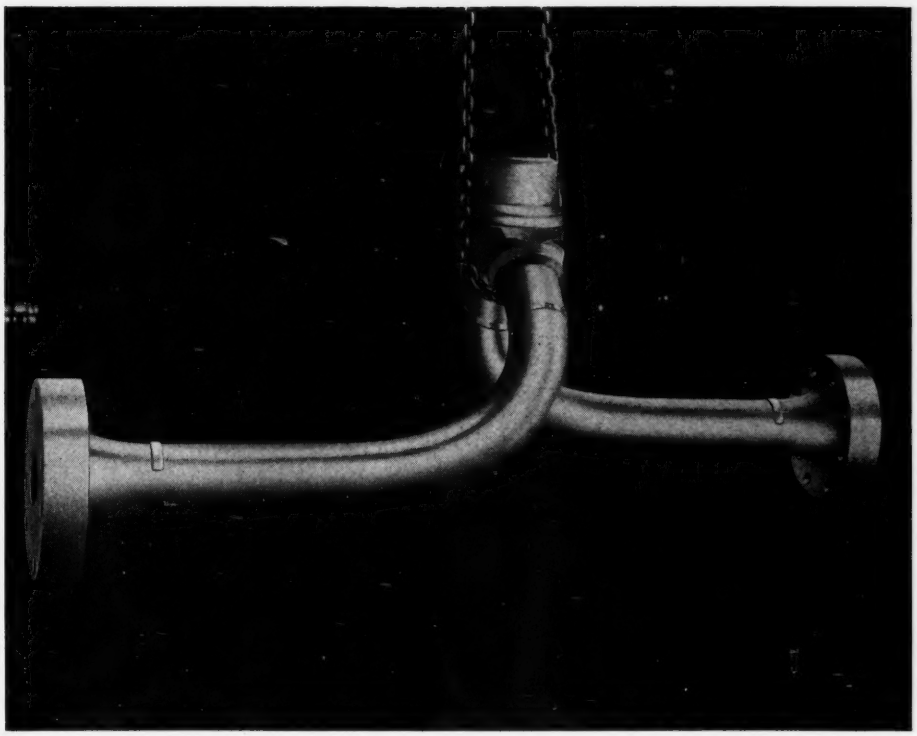
Complete Facilities for the fabrication of steel products from simple forgings to the most intricate 120 foot towers.

Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

On-Time Delivery made possible by a flexible planning group authorized to re-route work to meet promised dates.



Top Welding Performance assured by specially designed equipment and exclusive employment of master operators.



Up-to-the-minute . . . because 30 years are behind it

300,000 KW of new electrical power capacity depend on this and companion pieces of piping—destined to connect the throttles and steam chests of three new turbines in a large metropolitan powerhouse. They are made of 18-8 alloy steel—.718" thick, 6⅝" outside diameter, to operate at 1730 psig at 1050°F. There just can't be any defects, any locked-up stresses, any faulty metal formations, or deviations from contour, no matter how minor—not in piping as important as *this*.

Kellogg started preparing for this order more than thirty years ago . . . when a turbine was a textbook subject and 18-8 was just out of the laboratory. It was then that Kellogg started to amass alloy performance data . . . started to investigate methods of welding and heat treatment . . . established the nucleus of the present Kellogg Metallurgical Laboratory and Quality Control System.

The data, the amassed knowledge, the fabricating experience of thirty years are as apparent in the perfection of these vital power connections for industry as they are in the pioneering work which Kellogg metallurgists are now undertaking in the newer and more dramatic fields of gas turbine, rocket and ram jet propulsion devices.

When you place orders today with Kellogg for critical power piping you know that each piece of piping delivered, bearing the Kellogg stamp, will have this same thirty years of preparation behind it.

FABRICATED PRODUCTS DIVISION

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INC.

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PROCESS PIPING • FORGED AND WELDED FITTINGS . . . IN ALL STEELS, ALLOYS OR SPECIAL COMBINATIONS

What has Hector Dick to do with Duke Power?

Plenty!

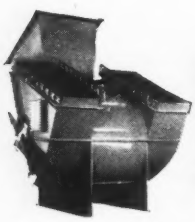
Hector Dick, veteran of 39 years with American Blower, is hard at work for Duke Power in the picture above. Another new Induced Draft Fan ordered by the Duke Power Company is the reason.

Here, Hector is making doubly sure that the operator of this giant shear is meeting every specification. And in the traditional American Blower manner, skilled craftsmen—men who have spent years in making power plant equipment—will check at every stage of the job to be sure that no detail is overlooked or left undone.

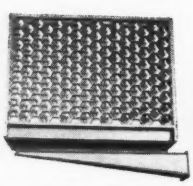
Hector Dick's viewpoint is typical of the attitude which is encouraged in all workers at American Blower. It is reflected over and over again in every step of design and fabrication. This goes a long way to insure every customer greater overall power plant efficiency and years of dependable performance.

America's great public utilities, like Duke Power, recognize this when they order and re-order American Blower Mechanical Draft Equipment, Fly Ash Precipitators and Gyrol Fluid Drives for boiler feed pumps and fan control.

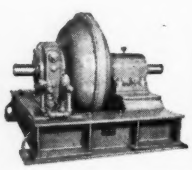
AMERICAN BLOWER CORPORATION, DETROIT 32, MICH.
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation



HS and Sirocco Fans for forced or induced draft in all types of power plants.



ST Fly Ash Precipitators—especially for power plants burning pulverized fuel.



Type VS Gyrol Fluid Drive—for adjustable speed control of mechanical draft fans.

AMERICAN BLOWER

Serving home and industry

AMERICAN STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILER • ROSS HEATER • TONAWANDA IRON

INGERSOLL-RAND BOILER-FEED PUMPS *for really HIGH pressures*

Each installation of high-pressure boiler-feed pumps is a specialized job. Factors such as plant layout, load factor, feedwater treatment, boiler pressure, etc., play an important part in the design of the boiler-feed pump and the materials used in its construction.

Ingersoll-Rand is eminently equipped to produce really high-pressure boiler-feed pumps for the most exacting service. I-R basic pump designs have been proven on many of the outstanding high-pressure installations. Unexcelled manufacturing, testing and metallurgical facilities insure dependable construction.

Ingersoll-Rand engineers will be glad to discuss with you the application of boiler-feed pumps to any type of plant.

Ingersoll-Rand High-Pressure Boiler-Feed Pump Installations above 1700 psi

Installation	Pump Discharge Pressure	Years in Service
A	2900	8
B	2180	7
C	1894	2
D	1890	8
E	1850	8
F	1850	8
G	1850	8
H	1830	8
I	1800	11
J	1800	7
K	1750	11
L	1750	11
M	1750	8
N	1745	2
O	1745	2
P	1720	9
Q	1720	8
R	1700	7

Many additional units in this pressure range are now in production.

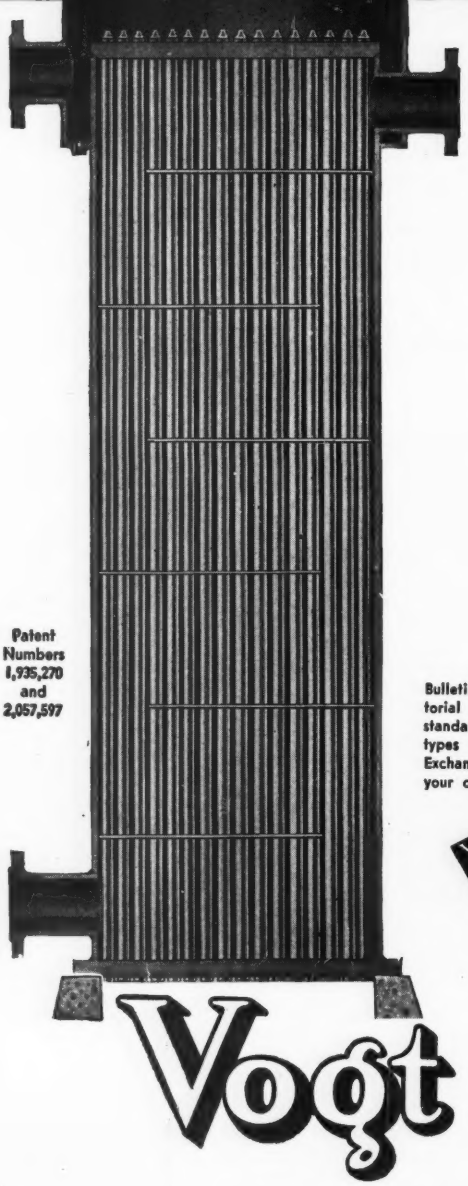
Ingersoll-Rand

283-10

AMERICAN PUMP DIVISION, 11 BROADWAY, NEW YORK 4, N.Y.

FILM TYPE EXCHANGERS

DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE (Patent Pending)



Patent Numbers 1,935,270 and 2,057,597

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

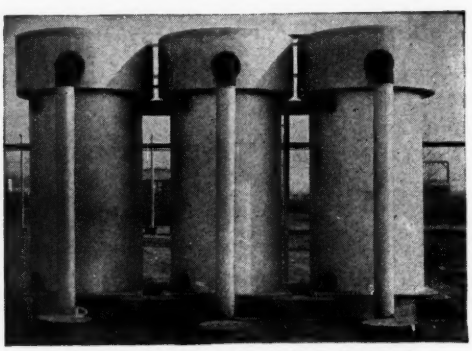
The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

HENRY VOGT MACHINE CO., INC.
LOUISVILLE 10, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.



Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT

THIS RIC-WIL *Copperclad* LINE GOES OVER THE TOP...

Foilclad Units for 62 ft. riser were connected on ground and hoisted into place.

TO IMPROVE STEAM SUPPLY

To meet operating demands for an adequate supply of process steam the engineers of Canada Packers, Ltd., Toronto, installed this new over-the-top steam line. Made up of 550 lineal feet of 8 inch pipe, it is designed to carry 80,000 pounds of steam per hour at 150 psi, 366°F.

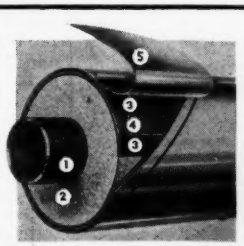
The line connects to a supply system running underground and rises vertically to form a huge expansion loop supported on the roof. Desired flexibility is obtained by shaping the structure to conform with roof contour and changes of roof elevation. The vertical pipe tangents absorb horizontal movement of the line due to expansion, while horizontal tangents perform a similar function with respect to vertical movement.

As specified, Ric-wiL pre-fabricated, pre-insulated Copperclad Piping was furnished in 21 foot tangents and elbow units, minimizing field erection costs. Ric-wiL sub-assemblies were scientifically designed to allow for pipe expansion and contraction, thus adding to the flexural properties of the system.

The Ric-wiL Copperclad Piping employed in this installation combines pipe, insulation, high temperature asphalt and spiral wrappings of asbestos felt and copper sheeting into thermally efficient units which are corrosion resistant and fully protected against the elements. This Ric-wiL construction is positive assurance of outstanding durability and long life with minimum upkeep and maintenance cost.

FOILCLAD CONSTRUCTION

1. Pipe as specified
2. Insulation
3. Double Coating of High-Temperature Asphalt
4. Asbestos Felt, Tension Wrapped
5. Copper or Aluminum Foil; Tension Wrapped



See Our Exhibit . . . Booth 827

HEATING & VENTILATING EXPO. — CHICAGO — JAN. 24-28

RIC-WIL

INSULATED PIPING SYSTEMS

THE RIC-WIL COMPANY • CLEVELAND, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

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The company your boiler keeps . . .

APEXIORIZED

New boilers APEXIORized during the past year alone are serving these industries:

CHEMICALS	MACHINERY
FOODS	PUBLISHING
PETROLEUM	UTILITIES
BREWERIES	GOVERNMENT
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COMING EVENTS

SESA—The Annual Meeting of the Society for Experimental Stress Analysis will be held in the Hotel Commodore, New York, December 2-4.

AIEE—Conference on Electric Welding to be held in Detroit, December 6-8.

DEMA—Engineers of the member companies of the Diesel Engine Manufacturers Association will hold a two-day meeting at the Union League Club, Chicago, on December 7 and 8.

ASHVE—The Ninth International Heating and Ventilating Exposition will be held in the International Amphitheater, Chicago, January 24-28.

ASTM—The Spring Meeting and ASTM Committee Week, to be held at the Edgewater Beach Hotel, Chicago, February 28 to March 4.

WMCE—The Sixth Western Metal Congress and Western Metal Exposition will be held at the Shrine Auditorium, Los Angeles, April 11-15.

NDHA—The 40th Annual Meeting of the National District Heating Assn. will be held at The New Ocean House, Swampscott, Mass., May 24-27.

ASTM—The 52nd Annual Meeting of the American Society of Testing Materials to be held at the Chalfonte-Haddon Hall, Atlantic City, June 27 to July 1.

ASTM—The First National meeting of the American Society of Testing Materials to be held on the West Coast will be held at the Fairmont Hotel, San Francisco, October 10-14.

PG & E'S EXPANSION PROGRAM

A DEVELOPMENT of major importance in the Pacific Gas and Electric Co. multi-million dollar power expansion program was revealed by the award to Bechtel Corp., San Francisco, of a contract for engineering and constructing one of the largest steam-electric generating stations ever built as a unit installation.

The new plant will be located on San Joaquin River frontage two miles east of Antioch, in central California. The total cost is estimated at $51,500,000.

When complete the new station will furnish 400,000 of the total of 2,000,000 hp PG&E is adding to its electrical system. Engineers of Bechtel Corp. are proceeding with the detailed design and specifications.

Field construction will start in 1949. Estimated completion will be in 1951.

Electrical power will be produced at Antioch by three steam turbine-driven 100,000 kw generators. The station will be equipped to burn either gas or oil, and equipment will be built and spaced to permit the addition of coal burning facilities later if needed.

Bechtel Corp. recently installed six 19,000 hp impulse-type water wheels, driving three 33,000 kva hydro-electric generators at PG&E's Electra Power House on the Mokelumne River, which have added their output to the utility's rapidly growing power supply.

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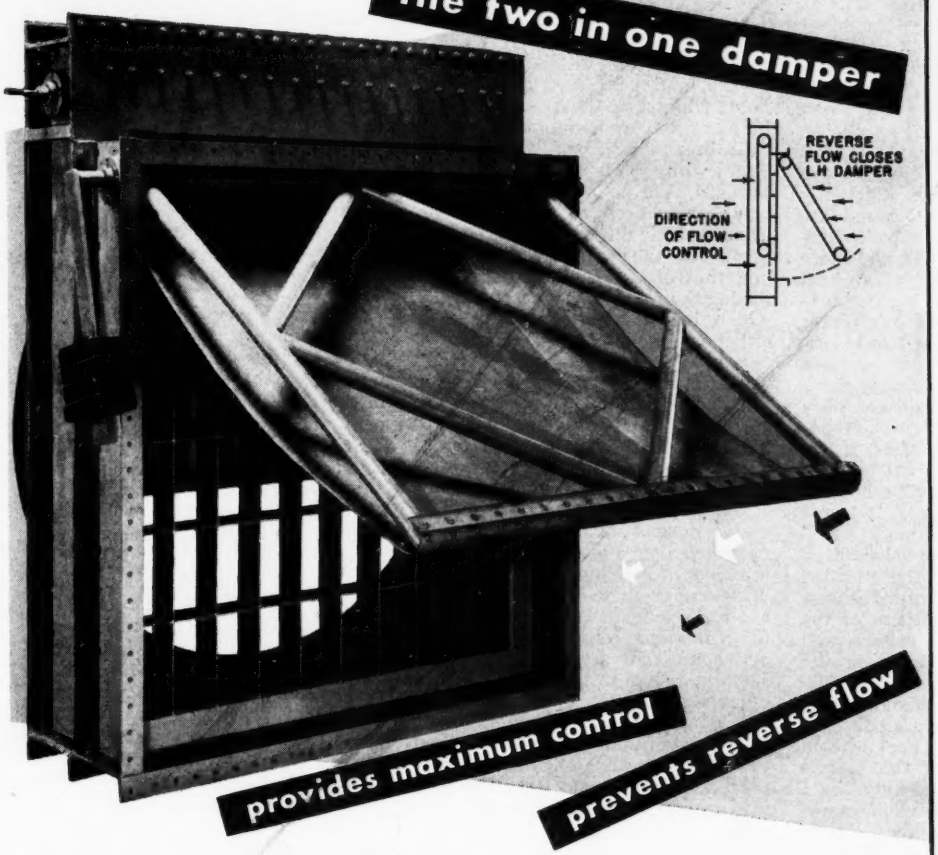

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This unit was designed to operate in tandem with two others, for the control of 3,000 h.p. blowers. It is actually a combination of two types: the SVH, seen partially closed through the grill, for regulating flow, and the LH, or leaf type, shown in open position on near side. This LH damper acts as a check valve to prevent reverse flow. Both damper curtains use a common grill and provide maximum control for the blowers.

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Protection of Belt Conveyors Against Bad Weather

Precautions to take against low temperatures, snow and rain . . . Lubrication precautions make it advisable to start belt slowly without load . . . Power requirements during starting period . . . Advantages by enclosing conveyor

By **WILBUR G. HUDSON** Consulting Engineer

IS IT DESIRABLE to keep an exposed belt in motion during extremely cold weather? That question was raised recently at a meeting of power engineers.

Inquiry of Commonwealth & Southern Corp., which has a number of generating stations in locations where rugged winters are common, brought the response that "nowhere do we operate the belts longer than necessary to handle the coal. We do not see how keeping them in motion during extremely cold temperatures can be of any advantage. Certainly the flexing of the belt around the end pulleys would not impart sufficient heat to keep the belt any more flexible and certainly this heat would be dissipated during its horizontal travel. In one of our plants where we have a wide belt outdoors, some 600 ft long, we have arranged for traveling the belt backward as well as forward, so in case of a heavy snow or rain, if the belt becomes full of snow or water, it can be discharged over the tail end instead of into the receiving hopper. After the belt has cleared, it is reversed to normal operation."

Since low temperature has little effect on the belt itself, the question turns on whether the chilled grease in the anti-friction bearings of the troughing and return rollers and terminal pulleys will increase the starting pull sufficiently to injure the belt or overload the motor. The United States Rubber Co.'s belt specialist comments, "the effect of cold weather on the life of the belt is not serious. In extremely cold weather it is advisable, when starting the belt, to turn it very slowly at first and then run it for a half hour without loading, or until the belt has limbered up and the lubricant in the bearings has warmed. Proper lubricants should of course be used. We now are back to prewar production of rubber belts. There is little difference between the action of the rubber construction and that of the Buna-S belts used during the war. However, Neoprene, which has a higher porosity than either rubber or Buna-S, is affected to a greater extent than rubber and will stiffen even in temperatures in the lower thirties. Neoprene will stiffen up quicker and take longer to soften up than rubber; therefore greater care must be used in starting up belts of this construction."

The power for starting a belt under normal conditions shoots up momentarily. Figure 1 shows the readings of horsepower input to the drive motor in a 36 in. belt 300 ft centers, inclined 18 deg, speed 360 fpm, handling iron ore at 900 tons per hour. The power input when starting (a) goes up to 125 hp, but quickly drops to a no-load reading (b) of 18 hp. At (c) the feeders were started and the power climbed to 104 hp as the load on the belt reached the head end (d). The feed was stopped (e) and the belt was empty again at (f). The motor was stopped at (g). It is noted that the starting load peak is 125 per cent of the fully loaded reading. This test was made in the summer with the temperature about 70 F.

Just how much more power the anti-friction bearings would absorb under freezing conditions is not known. Much depends on the lubricant with which the bearings are packed. Whatever the normal readings, probably the starting peak would double them. It might be noted that the double squirrel cage motor ordinarily used has a 240 per cent starting torque with 400 per cent starting current, and the maximum running torque is 200 per cent with five per cent slip, so if the motor can start rotating the chilled rolls, it can keep the conveyor moving.

We have assumed that the conveyor will be started empty. If started fully loaded, as might happen should the current fail during operation, the starting peak is much higher. The dotted line in Fig. 1 shows the power input under this condition—the conveyor started fully loaded and running until emptied (no feed). Here we see a starting peak of 200 per cent of the normal full load reading. The double squirrel cage motor still can start the belt. Of course we cannot, as with a flight conveyor or bucket elevator, use circuit-breaker protection but damage to a conveyor belt is caused by impact at the loading point, broken idlers, cuts by jammed fragments, and the like, reflected but slightly if at all by amperage increase.

The maximum working tensions for conveyor belts recommended by the manufacturers are well below the momentary tensions that the belt can sustain without injury, though there is the possibility that if the belt is spliced with metal lacing, this will suffer. The remedy is a vulcanized splice. Incidentally, allowable belt tensions have been stepped up sharply from the pre-war 45 lb per inch of width per ply for 42-oz

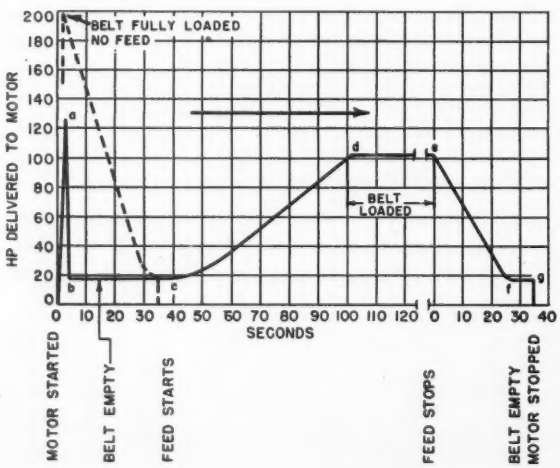


Fig. 1. Power input to belt conveyor drive motors under various loadings. Full line shows readings when conveyor is started empty and feeders started after belt is up to speed. Dotted line shows readings with belt started fully loaded

duck. The B. F. Goodrich Co. offers a belt with longitudinal cords embedded in the rubber and one or two plies of 42-oz duck for transverse strength, which is standardized for 50, 70, and 100 lb per inch of width per ply (cord layer). The United States Rubber Co. has a belt with carcass formed with a combination of Nylon and specially treated duck fabric with a rating of 150 lb per inch of width per ply. The Goodyear Tire and Rubber Co., for great lengths and heavy duty, offers belts with embedded wire cables, rated for tensions of 1000, 2000, and 3000 lb per inch of belt width and, where such extreme tensions are not involved, a belt with single layer of large diameter cords.

Advantages of Enclosure

Another question is whether there is any advantage in protecting or enclosing the belt otherwise exposed to severe weather conditions. There are factors in favor of belt protection. First, there is otherwise the risk of a strong cross wind lifting or overturning the belt. Again, if the drive side of the belt becomes wet, the traction of the drive pulley is lowered and slip between belt and drive pulley will cause serious damage. Moreover wet sharp material more readily cuts the belt cover than dry material.

A steel or cast-iron drive pulley loses most of its traction when wet. If there is reason to suspect that slippage may occur, the pulley should have a ½-in. rubber lagging vulcanized to the rim, with ¼ by ¼ in. grooves spaced ½ in. apart, in herringbone pattern. This has a squeeze effect, wiping the belt surface dry and substantially reducing both slip and creep.

(Creep refers to the elastic change in belt length on the drive pulley.

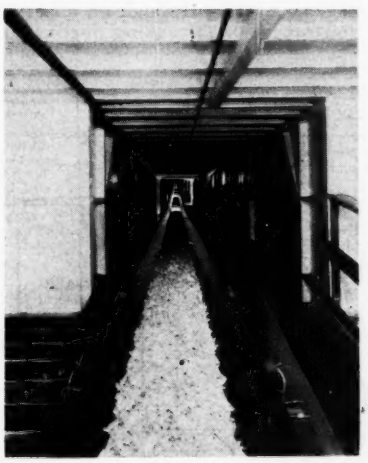


Fig. 2. View of 36-in. belt conveyor handling hogged fuel at western mill. A conveyor handling such material must be housed to prevent the load being blown from the belt by cross winds. (Photo courtesy Chain Belt Co.)

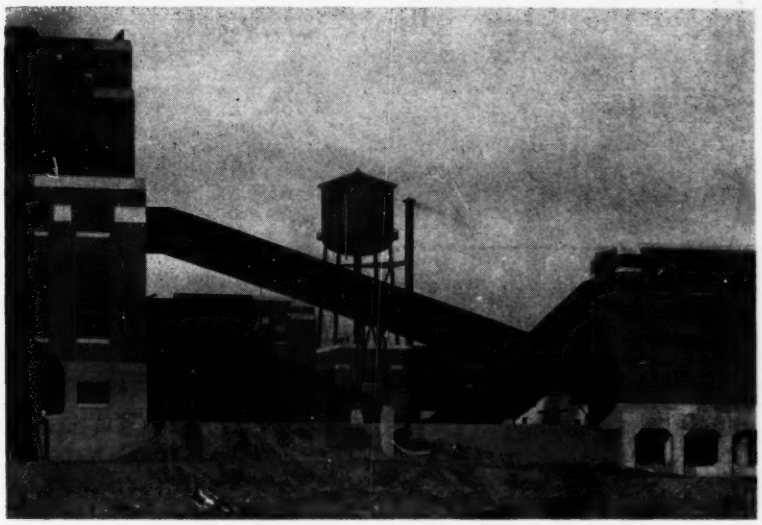


Fig. 3. Typical boiler plant belt conveyor installation with conveyors housed in sheathed bridges. Rear conveyor extends from track hopper feeder to Bradford breaker in structure at right. Near conveyor extends from beneath breaker across coal bunker (Photo courtesy Link-Belt Co.)

Conveyor belts stretch more or less, depending on carcass construction and load as they round the drive pulley and so creep is unavoidable. Both creep and slip cause wear on the pulley lagging—slip much more so than creep.)

Laboratory tests showed that there was little difference in slip and creep for a given horsepower under the three conditions of a belt on a grooved and lagged wet pulley and bare-faced dry pulley; while with a bare-faced wet pulley, slip started at a much lower point and increased sharply with increase in load.

Where several units are in tandem, as for example a feeder, crusher, inclined conveyor and belt above the bunker, it is essential to assure starting in sequence and to interlock, so that if one unit should stop or stall, the previous units will stop automatically. There is no objection to having the interlocks stop all units, but if only those ahead of the stalled unit stop, the trouble is located more readily.

With the current use of small sizes of bituminous and anthracite coals, often wet and sticky, cleaning the belt has become more difficult. If a substantial residue adheres to the cover, the return idlers and the second snub pulley of the tripper become crown-face and alignment is difficult to maintain. The counterweighted scraper is altogether unsuitable. Short diagonal strips of thin steel, overlapping slightly, and with a moderate pressure against the belt surface, provide very efficient cleaning.

The preceding comments relating to the operation of conveyors under low temperature conditions refer primarily to coal handling installations. There are belt conveyors

(Continued on page 138)

SOME DO'S AND DONT'S FOR CONVEYOR BELTS

If there is the possibility that oil-sprayed coal must be handled, specify a belt with cover of one of the synthetics (Neoprene, etc.) resistant to the destructive action of oils and greases. Rubber as ordinarily compounded may last one month. Neoprene covers observed over a period of three years showed no ill effect.

With small sizes of damp coal, especially anthracite buckwheat, provide a more effective belt cleaner than the single scraper or rotary brush, especially if a weightometer is in the line.

Don't let the feed strike the belt where it rests on unyielding idlers.

Don't regard the self-aligning idler unit as correction for misalignment. It is merely an indicator of needed correction.

Don't maintain the belt at a speed at which it runs with only part of the belt width utilized.

Don't overlook the necessity of a decking to prevent material dropping on the return run.

Don't let spilled coal accumulate and jam the troughing idlers.

Don't squeeze unneeded grease into the idler alemite fittings, forcing it out and smearing the belt. These sealed anti-friction bearings require attention about as often as those in the front wheels of your automobile.

Watch the belt covers. If they show cuts or bruises something is wrong. The lagging of the drive pulley may show projecting bolts, the loading chute and skirt-boards may require adjustment, an idler rim may be broken, or the discharge chute may be too high and is jamming lumps between upper edge and the belt as the conveyor comes up to speed or is stopped.

Watch the drive pulley face for indication of slip. Is the take-up providing sufficient slack-side tension?

How the New Elliott Oxygen System Works

By B. H. VAN DYKE, Elliott Company

***Editor's Note*—Because of the great and growing interest in uses of oxygen in industry, and the present speculations of engineers on the possibilities of using oxygen in the combustion process itself, this recent announcement is presented.**

Commercial applications are now well advanced in the use of oxygen in open-hearth furnaces, blast furnaces, Bessemer converters and electric furnaces. We have seen one open-hearth furnace in normal operation using oxygen (*Power Generation*, May, 1948, page 57) and others are in operation or being projected. Use of oxygen is expected to increase output and economy of these furnaces.

At least one company is experimenting with use of oxygen in combustion in the furnace of a steam generating unit. Quantity oxygen is an essential in the synthetic gasoline processes now under construction. Combinations of oxygen and natural gas or coal open up new sources of liquid fuels and chemicals (P.G. January 1948), may eventually make the United States independent of the rest of the world for liquid fuels. Use of oxygen in underground gasification of coal (P.G. October, 1948) is under test and may help in generating at the mine a pipeline gas for power, industrial and domestic use.

For all those reasons, this new oxygen process, all conducted at low pressure under complete automatic control and designed for safety and economy, should interest power engineers.

THE NEW Elliott oxygen process recently announced is an atmospheric pressure air distillation system, combined with a nitrogen liquefaction and refrigeration system in such a manner as to provide a unique combination of features and an unusual degree of safety and flexibility in operation.

Features claimed for it are:

1. The plant is not subjected to the necessity for periodic shutdowns for deriming.
2. The system is completely immune to possible dangers of acetylene explosions.
3. The system operates at reduced loads without sacrifice of efficiency.
4. The system is mechanically simplified.
5. All controls are automatic. They can be set to maintain constant purity over the entire range of operating conditions, or the purity can be varied at will by a simple adjustment.
6. The recovery of oxygen from the air charged to the system is over 97 per cent. The nitrogen leaving the process is over 99.5 per cent pure.
7. Oxygen of any purity can be made.
8. A plant designed for 95 per cent purity can also simultaneously produce 99.5 per cent welding grade oxygen in quantities as required for this purpose.

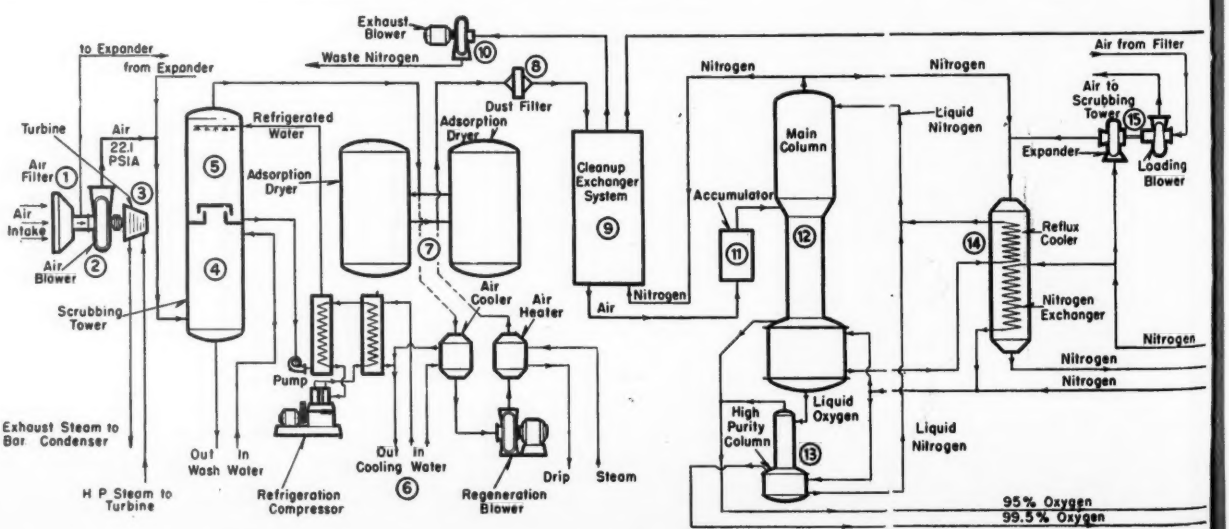
The simplified flow diagram shown is for a plant designed to produce approximately 114 tons per day of 95 per cent purity gaseous oxygen, plus approximately 6 tons per day of 99.5 per cent high-purity gaseous oxygen, plus 332 tons per day of 99.5 per cent purity dry nitrogen. The recovery of oxygen from the air charged to the plant is approximately 97.5 per cent. The nitrogen product may be used for chemical synthesis without further purification. If a nitrogen product of higher purity is desired, it may also be obtained. The supplemental high purity oxygen product is made without increasing the horsepower per total unit of oxygen produced by the plant. This has the effect, in many instances, of making it possible for the user to obtain his full requirement of high-purity oxygen at the same cost per ton as the low-purity oxygen.

Flow Through System

Starting at the left-hand side of the diagram, outside air enters through filter (1) and is compressed in an Elliott single-stage centrifugal blower (2) to a pressure only sufficiently above atmospheric to overcome friction loss in the equipment. A portion of the incoming air is compressed to the same pressure through the expander blowers (15), which parallel the air charging blower (2). This discharge from the expander blower joins with the discharge from the air-charging blower and flows into the bottom of a double scrubbing tower (4).

The air is dehumidified and freed of dust, before entering the clean-up heat exchangers. This is accomplished by the use of a scrubbing tower in two stages (4) and (5). The power required for the refrigeration system (6) is a small item charged against the total power for the production of oxygen.

The air is next further dehumidified by passing through an absorption drier (7), using activated



alumina or similar desiccant and provided in duplicate for regeneration. The air leaving the drier will be at approximately plus 70 F, and a dewpoint of minus 40 F. A dust filter (8) is provided to remove traces of dust which might break loose from the drier during the early stages of operation.

In the clean-up heat exchanger system (9), the air is cooled to approximately minus 310 F by nitrogen from the top of the column (12) and enters the heat exchangers at approximately minus 318 F. In the cooling, water vapor, carbon dioxide, and other impurities in the air will be frozen out on the heat exchanger surface, which eventually will plug the passages unless some provision is made for cleaning.

The nitrogen leaving the warm end of the clean-up heat exchanger, 8 to 10 deg lower than the entering air, is bone dry and is used in quantity as required to regenerate or remove deposited impurities from the heat exchanger. The system is arranged so that, through a combination of automatic valves on a fixed time cycle, one heat exchanger bank at a time is switched from service and purged of deposited impurities.

It has been found economical to install a small exhaust blower (10) to suck the small amount of nitrogen required for the clean-up operation through the exchanger being cleaned. The nitrogen discharging from this blower will then carry to waste all of the impurities previously deposited from the air.

Heat Exchanger Details

The exchangers are automatically switched out of service for purging every four hours. By reducing the dewpoint of the air to minus 40 F before entering the clean-up heat exchanger system, the time for clean-up of the exchange with respect to water vapor is brought into balance with the time for carbon dioxide. No economic benefit will result from further reduction of the dewpoint of the entering air.

By accepted concepts of heat transfer, such as would be obtained with conventional shell and bare tube surface, over 100,000 sq ft would be required to perform the air-to-nitrogen exchange. Such a heat exchanger would not be practical. Hence design of suitable heat exchangers was imperative and has resulted in a heat exchanger surface which can be built in standardized sections at moderate cost. The heat exchanger lends itself to mass production techniques and the same standardized sections may be used for any plant regardless of capacity. This minimizes the replacement problem and lowers the plant investment.

The heat exchanger consists essentially of thin copper fins furnace bonded between brass plates. The exchanger is manifolded so that one fluid will flow in one direction through every alternate passage and the other fluid will flow in the opposite direction through the intermediate passages. This arrangement of surface provides over 300 sq ft of effective surface per cubic foot of heat exchanger volume and corresponds to over 3.5 sq ft per pound of metal.

The fact that the air leaving the clean-up heat exchanger is at approximately 18 psia and minus 310 F constitutes the basis for the extremely effective removal of impurities by the Elliott system.

By contrast, in other types of oxygen plants, the air at the corresponding point in the system is at a temperature of approximately minus 270 F, and a pressure of approximately 90 psia. The difference in temperature of about 40 F is of great importance since in these lower temperature ranges the vapor pressure of carbon dioxide and other impurities decreases very rapidly with temperature.

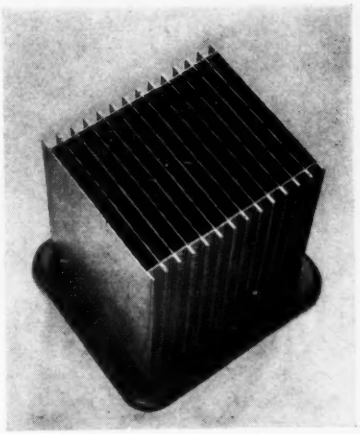


Fig. 2. Section model of gas-to-gas heat exchanger

Since plant shutdowns are apparently caused by accumulated deposits of carbon dioxide and since the Elliott clean-up system reduces the quantity of carbon dioxide by a large ratio over other systems, the Elliott system will not have to shut down for process reasons, and can run indefinitely except for periods of regular maintenance of the rotating machinery.

An accumulator (9) is provided in the air stream between the clean-up heat exchanger system and the main column to balance out the pressure and temperature fluctuations which occur to a slight degree when a heat exchanger is switched. In the Elliott system the differential pressure between the two sides of the heat exchanger that are being switched is only a few pounds gage; thus the surge is very slight, and the operation takes place only once every four hours instead of every few minutes.

Distillation of Oxygen and Nitrogen

The air leaving the equalizer or accumulator enters the main column (12) at the appropriate tray. Distillation takes place in the column and results in liquid oxygen collecting in the reboiler at a purity corresponding to the purity of the principal oxygen product, which for the case being described is 95 per cent. The gaseous oxygen product is taken off at approximately 5 psig and the corresponding saturation temperature and warmed up to room temperature through heat exchanger (17). Thus the cold from the oxygen product is returned to the system via the high-pressure nitrogen stream.

To provide refrigeration for precooling the air entering the process, nitrogen from the top of the fractionating column is supplied through a heat-exchange (14), (16), (17), (18) and compressor system (19), which also makes up warm-end

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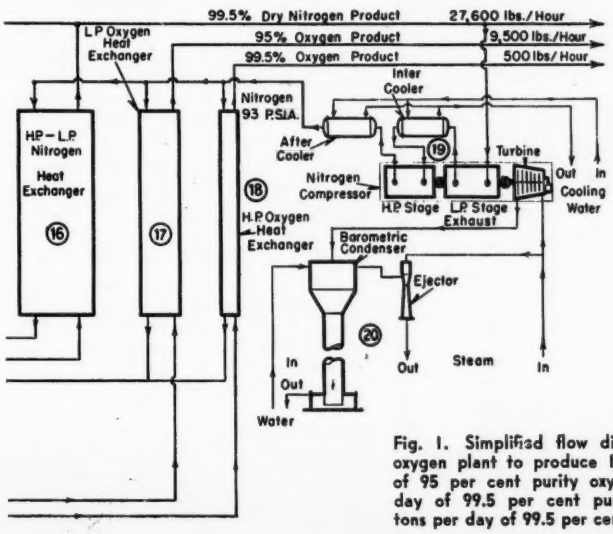


Fig. 1. Simplified flow diagram of Elliott oxygen plant to produce 114 tons per day of 95 per cent purity oxygen; 6 tons per day of 99.5 per cent purity oxygen; 332 tons per day of 99.5 per cent purity nitrogen

Using MANOMETERS In the POWER PLANT

The manometer is perhaps the simplest of all instruments used in industry and one that is very useful. It can be used to measure fluid and gas static pressures and also the flow of fluids and gases in terms of differential pressures developed across portions of the flow. Since nearly all operating engineers have occasion to use these devices this article by Tyler Hicks, describing their basic theory, should be of general interest

By **TYLER HICKS** Hicks Associates, New York, N. Y.

MANOMETERS are widely used for static pressure determinations in power plant test work and routine power plant operation. Because they are simple to operate, easy to read, and of low cost, they are used to measure fluid and gas static pressures above and below atmospheric, and static pressure differentials. The application of manometers to such diverse jobs requires a rather specialized knowledge of the basic manometer types, the rules governing their operation, and the limitations of each type. This knowledge can readily be obtained by a brief study of the manometer and what it does.

Basically a manometer is a tube, straight or U-shaped, containing a liquid of known specific gravity. The meniscus of the liquid moves proportionally to changes of pressure in a fluid pipe line when the manometer is connected to it. Two types of manometers are in common use in power plants. These are: (1) the open type which has atmospheric pressure acting on one surface of the liquid in the tube, and (2) the differential type which does not have an atmospheric surface and measures only pressure differentials. Figures 1 and 2 show the various types of open manometers which can be used in power plant work. In Figs. 3 to 6 several types of differential manometers are shown.

The simplest types of open manometers are those shown in Fig. 1. Consisting of a single tube tapped into the top, bottom, or side of the pipe or pressure vessel, they are often called piezometers. Since atmospheric pressure is acting on the fluid in the tube these manometers measure gage pressures. That is, if the pipe or vessel pressure is greater than atmospheric, the pressure reading obtained from the manometer is the same as that which would be obtained from a pressure gage properly tapped into the line at the same point along the pipe. To obtain the absolute pressure in the pipe or vessel the manometer reading must be added to the existing atmospheric pressure, using consistent units of pressure. For Figs. 1a, 1b, and 1c, using the symbols given,

$$p_t = w_f h \qquad (1)$$

Also, for all these manometers,

$$p'_t = h' \qquad (1a)$$

for pressures greater than atmospheric. For pressures less than atmospheric with manometers as shown in Figures 1d and 2a,

$$p_t = pa - w_f h \qquad (2)$$

For the inclined tube manometer shown in Fig. 2b, when used for measuring gas pressures greater than atmospheric,

$$p_t = w_m \sin \ominus (ROL - RL + RR - ROR) \qquad (3)$$

using the dimensions shown on the sketch and expressing them in feet before substitution. A similar relation can readily be derived for pressures less than atmospheric.

The open manometers discussed thus far are suitable for the measurement of only small pressures because as the pressure increases the required tube length also increases. To obviate the necessity of extreme-

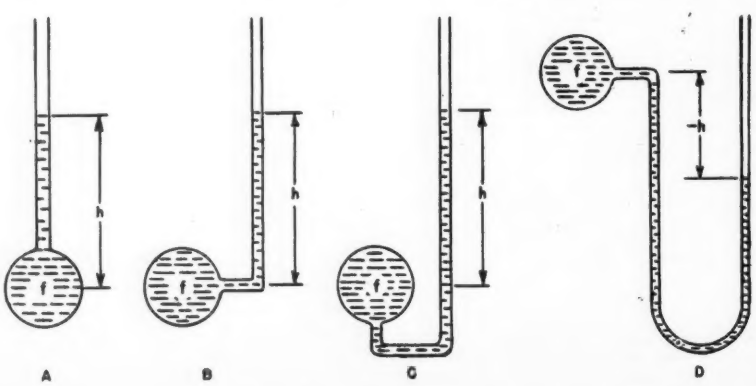


Fig. 1. Types of open manometers

SYMBOLS

p_f, p_x, p_y	= fluid pressure, lb per sq ft
p'_f	= fluid pressure, inches of fluid
p_a	= atmospheric pressure, lb per sq ft
h	= pressure head, ft of manometer fluid
h'	= pressure head, inches of manometer fluid
z	= distance between pipe centerline and surface of manometer fluid, ft
w_f	= density of fluid flowing, lb per cu ft
w_m	= density of manometer fluid, lb per cu ft
s_f	= specific gravity of fluid flowing
s_m	= specific gravity of manometer fluid
H_x, H_y	= fluid pressures, ft of fluid flowing
m_1, m_2	= subscripts denoting manometer fluids of different densities

ly long tubes a second fluid of greater density is frequently used in the tube as shown in Figure 2c. The most frequently used fluid is mercury. For the manometer in Figure 2c,

$$p_f = w_m h - w_f z \qquad (4)$$

Typical Calculations

To illustrate typical calculations which are encountered when open manometers are used, assume that the value of h in Figure 2c is 24 in., z is 12 in., the manometer fluid is mercury, and that water is flowing in the pipe. Then, from equation 4,

$$p_f = w_m h - w_f z$$
$$= 848\left(\frac{24}{12}\right) - 62.4\left(\frac{12}{12}\right)$$

using w_m = average density of mercury = 848 lb per cu ft, and w_f = density of water = 62.4 lb cu ft.

p_f = 1631.6 lb per sq ft or $\frac{1631.6}{144}$ = 11.3 psig

It should be noted that all readings of fluid movement are expressed in feet because the density units are in terms of lb per cu ft.

Thus it can be seen that open manometer calculations are simple provided consistent units are used throughout a given problem. In cases where the fluid temperatures vary considerably from ordinary room temperatures, the densities of the fluids at the existing temperature should be used for accurate results. Frequently the specific gravity of the manometer and pipe line fluids are used in place of their densities. The specific gravity is simply the ratio of the density of the manometer fluid to that of water at 39 F. Therefore the preceding formulas can easily be converted to terms of specific gravity by substituting s_m, for w_m, s_f for w_f, and multiplying by the density of water at the manometer fluid temperature. Thus, in the problem above, using specific gravities at 70 F from Table I,

$$p_f = \left\{13.54\left(\frac{24}{12}\right) - 0.998\left(\frac{12}{12}\right)\right\} 62.4$$

p_f = 1631.6 lb per sq ft or 11.3 psig as before. If the pressure head in feet of fluid flowing is desired, sim-

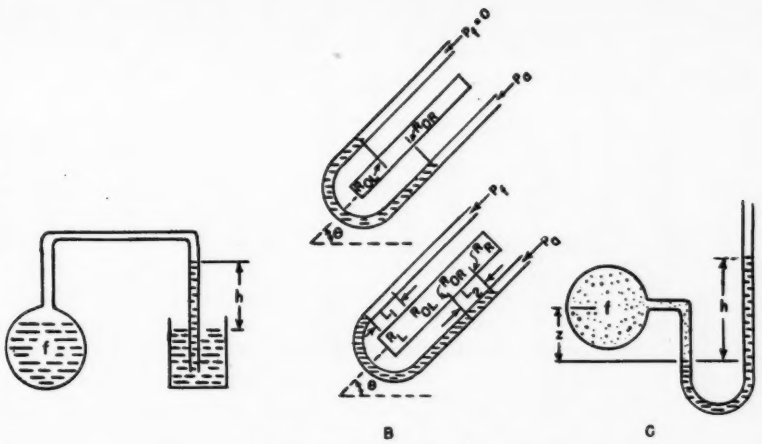
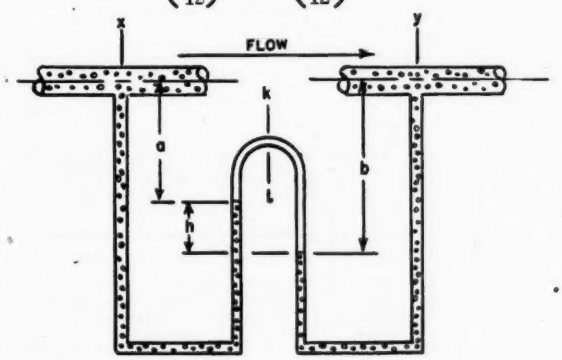
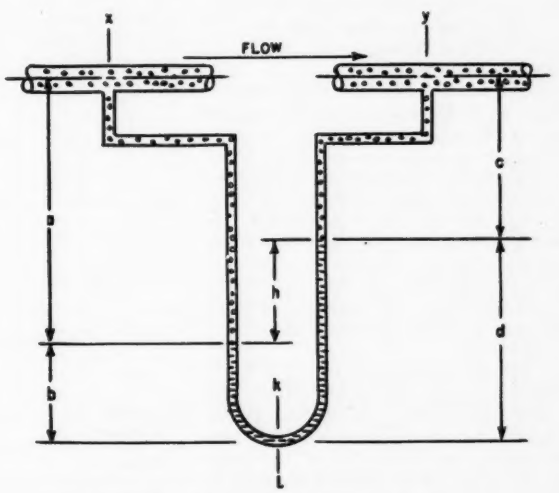


Fig. 2. Other types of open manometers



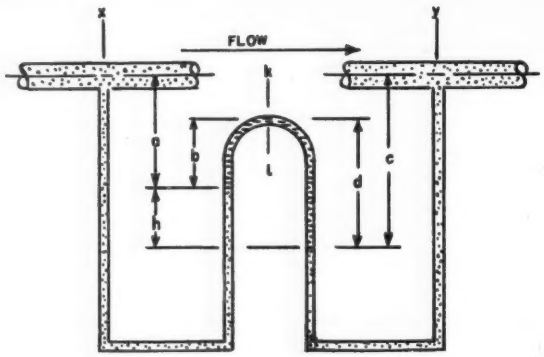
$$p_x + w_m a = p_y + w_m b$$
$$p_x - p_y = w_m(b-a), \text{ but}$$
$$b - a = h, \text{ and}$$
$$p_x - p_y = w_m h \qquad (5)$$
Also,
$$H_x - H_y = h \qquad (5a)$$

Fig. 3. Direct reading differential manometer



$$p_x + w_f a + w_m b = p_y + w_f c + w_m d$$
$$p_x - p_y = w_f(c-a) + w_m(d-b),$$
But, $c-a = -h$, $d-b = h$,
And $$p_x - p_y = h(w_m - w_f) \qquad (6)$$
Also,
$$H_x - H_y = h\left(\frac{s_m - s_f}{s_f}\right) \qquad (6a)$$

Fig. 4. Diminishing type differential manometer



$$p_x + w_f a - w_m b = p_y + w_f c - w_m (d)$$
$$p_x - p_y = w_f (c-a) + w_m (b-d)$$

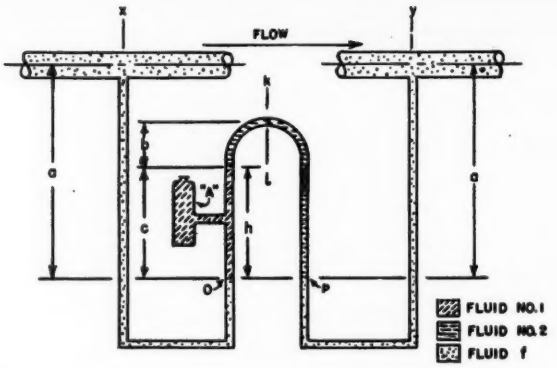
But, $c-a = h$, $b-d = -h$,

And $$p_x - p_y = h(w_f - w_m) \qquad (7)$$

Also,

$$H_x - H_y = h\left(\frac{s_f - s_m}{s_f}\right) \qquad (7a)$$

Fig. 5. Enlarging type differential manometer



$$p_x + w_f a - w_{m1} c - w_{m2} b = p_y + w_f a - w_{m2}(b+c)$$
$$p_x - p_y = w_{m2}(b-b-c) + w_{m1} c$$

But, $-c = -h$, $c = h$,

And $$p_x - p_y = h(w_{m1} - w_{m2}) \qquad (8)$$

Also,

$$H_x - H_y = h\left(\frac{s_{m1} - s_{m2}}{s_f}\right) \qquad (8a)$$

Fig. 6. Dual fluid enlarging manometer

ply omit the 62.4 from the above calculation. Table I also contains factors for rapid conversion from inches of various liquids to psi. These factors are included because low pressures read by means of manometers are often stated in terms of inches of manometer fluid as given in Equation 1a, instead of lb per sq ft, which is used for higher pressures. Fluids which are lighter than water have been listed because they are frequently used for small pressure measurements.

Differential Manometers

Differential manometers can be conveniently classed as follows:

(1) Direct reading type
(2) Diminishing type
(3) Enlarging type
(4) Dual fluid enlarging type

This classification covers the major types which are encountered in power plant operation and testing.

The direct reading type of differential manometer is shown in Fig. 3. By use of this manometer the static pressure difference between points x and y can be readily obtained. Neglecting the extremely small difference in the weights of the air columns on each side of the line kl,

$$px—py = w_m h \qquad (5)$$

after equating static pressures and collecting terms. This equation states that the difference in static pressures between points x and y is equal to the product of w_m and h. Since pressure can also be expressed in terms of feet of the fluid flowing, equation 5 could be written as,

$$Hx—Hy = h \qquad (5a)$$

In pipe lines where large pressure differentials are encountered the diminishing type of manometer is generally used in place of the direct reading type because the size of the latter would be prohibitive. A typical diminishing manometer is shown in Fig. 4. For this type

$$px—py = h(w_m—w_f) \qquad (6)$$

after equating static pressures and collecting terms. Also,

$$Hx—Hy = h\left(\frac{s_m—s_f}{s_f}\right) \qquad (6a)$$

To obtain a small deflection when large pressure differentials are to be measured, a manometer fluid which has a greater density than the fluid flowing is usually chosen for the diminishing manometer. Naturally, the two fluids must be insoluble.

In many applications the differential pressure to be measured is extremely small. The direct reading and diminishing types are of little use for this work because the deflections obtained are usually too small to be read accurately. Hence the enlarging manometer is used. Figure 5 shows one arrangement of this type. By equating static pressures and collecting terms,

$$px—py = h(w_f—w_m) \qquad (7)$$

Also,

$$Hx—Hy = h\left(\frac{s_f—s_m}{s_f}\right) \qquad (7a)$$

In the enlarging type, the manometer fluid used has a density slightly less than that of the fluid flowing. A reading deflection is thereby obtained. As before, the fluids should be insoluble.

Occasionally when trying to use the direct reading type it is difficult to obtain a manometer fluid with a density slightly less than that of the fluid flowing and insoluble with it. However, if two manometer fluids with about the same specific gravities are available, an enlarging ma-

(Continued on page 140)

Table I

Properties of Manometer Liquids *

Manometer Liquid	Specific Gravity Relative to Water at 39 F		To Convert Inches of Liquid to psi, Multiply by	
	Manometer Temp 70 F	Manometer Temp 32 F	Manometer Temp 70 F	Manometer Temp 32 F
Mercury	13.54	13.595	0.489	0.491
Water	0.998	——	0.0361	——
Kerosene (44-46 deg A.P.I.fl)	0.799	0.812	0.0289	0.0293
Red draft gage oil (approx.)	0.820	0.835	0.0296	0.0301
Methyl (wood) alcohol	0.790	0.810	0.0285	0.0293
Ethyl (grain) alcohol	0.789	0.805	0.0285	0.0291
Gasoline (58-60 deg A.P.I.)	0.739	0.752	0.0267	0.0270

* After Marks

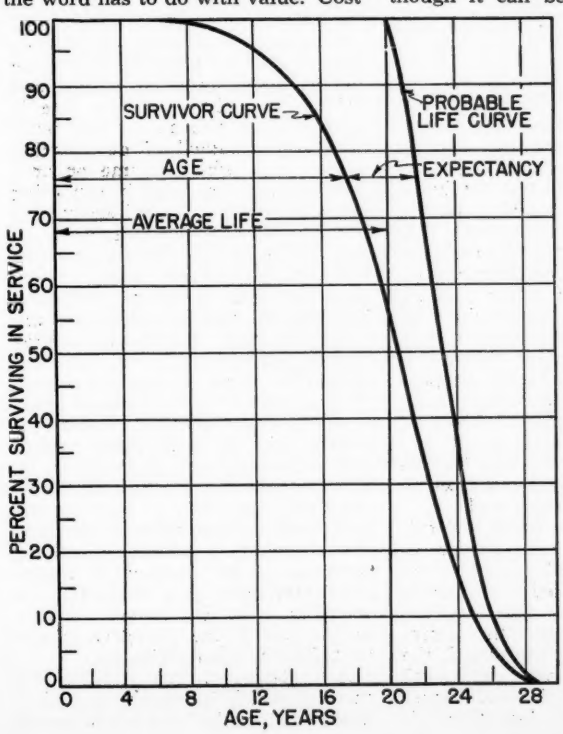
Depreciation Need Not Be a Mystery to Power Engineers

Depreciation an estimated quantity based on judgment . . . Why depreciation is an element of cost to power engineer and accountant . . . Spreads costs of physical equipment over several periods or over number of units produced . . . Depreciation not to provide for replacement costs but only to get back original equipment costs . . . How it affects planning for expansion or modernization . . . Unless it is included in price of goods and services, capital of business will be consumed . . . Relations of depreciation to net profit . . . How fix depreciation rates . . . Depreciation and taxes . . . Economic and physical equipment life . . . How to figure when it pays to replace equipment . . . Differences between depreciation rates of public utility and industrial power plants

By **ROBLEY WINFREY** Research Professor of Engineering Valuation, Iowa State College

ANY MYSTERIES connected with the word "depreciation" are in its usage rather than in the accounting and valuation applications of depreciation. Some owners of small businesses have been mystified, however, by their ultimate losses, because they did not take into consideration the depreciation costs of their business. Thus, the first thing to be learned about depreciation is that unless the costs attributable to it are included in the price of goods or services, the capital of the business will be consumed.

This first and foremost concept of depreciation treats it as an element of cost. The second application of the word has to do with value. Cost and value must always be differentiated; likewise, the term depreciation must be defined when discussing cost and value. In ordinary conversation, it is frequently said that an article of property—machine, building, or tool—is greatly depreciated. What specifically is meant, the speaker usually does not say; but he depends upon the situation at the moment to supply the necessary explanation. What the speaker probably means when he refers to specific property is that it is badly worn, in need of maintenance, and otherwise unfit for satisfactory service. Here, no reference is made at all to the cost or value of the article, though it can be implied that the speaker values the property relatively low. This is the third concept of the term depreciation which prevails among craftsmen, technical men, and executives.



Typical survivor and probable life curves for industrial property

Because of these three usages of the term depreciation, there have appeared in the press, over a period of years, many controversial writings, the basis of which has been the fundamental concept of depreciation, rather than any basic differences in theory or practice. This is not implying that engineers, accountants, managements, and tax officials, all of whom must deal with depreciation, are agreed on the procedures to be followed in estimating depreciation for either accounting or valuation purposes. In fact, these professional men are not agreed on how to handle depreciation in these fields, principally because depreciation must always be an estimated quantity based upon judgment. The judgment of experts differs on depreciation just as it does in the design of power plants and the selection of machinery.

Depreciation as an Element of Cost

In this article, depreciation from the concept of value will not be considered to any great extent. As an element of value, depreciation is considered mainly as a deduction from a base figure, value new, in order to obtain present value. This application is common in valuation of public utilities for rate-making purposes, in settlement of insurance claims, in settlement of estates, and in evaluating property for sale or condemnation. But depreciation as a cost is what the accountant is concerned with; also, it is what the plant superintendent is concerned with in economy studies.

When a new generator is purchased and installed in the power plant of a manufacturing company, management is concerned with two financial matters: Getting its invested capital back, and earning a

Table I. Cost of operating old machine for another year

Estimated secondhand or scrap value of old machine as of today	$3,000	
Estimated secondhand or scrap value of old machine one year from today	$2,500	
Equivalent depreciation charge for next year		$ 500
Nominal interest charge at 6 per cent		180
Operating expenses of labor, supplies, maintenance, and repairs		16,000
Estimated cost to company because of shutdowns on account of mechanical trouble with old machine		2,000
Total cost to company of operating the old machine another year		$18,680

Table II. Annual cost of operating proposed new machine costing $30,000 Installed

	5-year basis	10-year basis
Annual depreciation charge, based on 10% and 5% salvage	$ 5,400	$ 2,850
Nominal interest charge at 6% on average investment	990	945
Estimated operating expenses of labor, supplies, maintenance, and repairs	8,000	8,500
Estimated cost to company of shutdown during installation of new machine	500	500
Estimated cost to company because of shutdowns on account of mechanical trouble	none	500
Total estimated annual cost of operating new machine	$14,890	$13,295

reasonable return on that portion of the investment that remains invested year to year. Reference is made to "that portion of the investment" because, as part of the original investment (cost) is returned in the form of depreciation charges each year, the net investment decreases. Thus, the manner in which management gets its investment back is by including each month some fraction of the original cost in its operating expenses. This is recognized as equitable, and is the universally accepted procedure of spreading the initial cost of the generator or other property over several accounting periods.

The original cost of the generator becomes an investment only because it is not fully charged to operating expense and recovered through income in the current year of purchase. The cost of fuel, labor, and minor repairs are exactly the same type of cost, except that they, unlike the costs of the generator, are for goods and services consumed during the year current with their purchase. The generator is consumed over several years; therefore, to prevent the unbalancing of the profit and loss statement for the year in which the generator is purchased, its cost is spread into the future. Depreciation accounting, then, is simply the allocating of prepaid costs of physical properties to the several accounting periods chosen by the particular company and the property involved.

Depreciation and Net Profit

Depreciation as an element of cost enters into the functions of management: a) as a deduction from income, which must be made before true profit is determined; b) as an element in determining the price at which its goods and services can be sold; and c) as a cost consideration in planning for expansion or modernization. In each of these considerations, the basic application is spreading the cost (purchase price plus expenditures to make the property ready to use) of physical properties over several accounting periods, or over the number of units to be produced. The cost of depreciation is an important item in determining profit, both from the standpoint of what profit is available for dividend payments and what the taxable net income is.

Federal income taxes are based upon net income after deduction for depreciation. Large charges for depreciation decrease stated profits and thereby reduce income taxes. Temporarily, at least, the taxes may be reduced; but, in the long run, the effect is uncertain, because once the cost of the property has been fully recovered in the form of depreciation charges, no further deductions can be made for depreciation in estimating net income for tax purposes. Management's problem, here, is to outguess the future tax rates and tax provisions. However, once a depreciation policy is put into practice by a corporation, it cannot be changed for purposes of income tax returns without approval of the Bureau of Internal Revenue. The purpose of this provision is obvious—the government wants protection against the changing of depreciation rates for the sole purpose of obtaining tax benefits.

Depreciation Reserve Account

Unless some specific record is kept year to year of the amounts charged to operation expenses for depreciation, the company would not know how much of the costs of its capital properties had been recovered. This is the function of the depreciation reserve account. The depreciation reserve, as reported in the balance sheet, is nothing more than the total of the charges for depreciation that, in the past, were made to expense on account of the depreciable properties then existing. This balance, subtracted from the original costs of these properties, results in the net remaining investment—that is, the portion of the original costs which have not yet been recovered.

It must be kept in mind that this so-called reserve is not a reserve at all, but merely a book account indicating the accumulated past charges for depreciation on the existing property. It is true that the equivalent sum in cash (provided the company's income was sufficient) was reserved from income before profits were stated, but there is usually no such reserve maintained. The cash is used just the same as other cash is used—for working capital, plant expansion, new equipment, or investments, in accordance with the needs of the company at the time.

The purpose of depreciation accounting is not to build up reserves for the replacement of the property being depreciated. In fact, there is no connection at all between replacing depreciable units of property and the fact that the cost of the unit of property retired was recovered through depreciation charges. This is true because the fundamental purpose of depreciation accounting is to recover prepaid costs; financing the replacement machine or plant is an entirely separate transaction. It should be further realized that seldom is a machine or plant replaced as such. Newer equipment is usually of different design and frequently of different function.

Methods of Fixing Depreciation Rates

How much depreciation on a given unit or class of property to charge during the year must be decided strictly by judgment. The rate is governed by two main considerations:—the method of depreciation chosen; and whether time or production units are used in spreading the cost over the several accounting periods. Of depreciation methods, the choice is between the straight line, or zero-interest method, and some method involving compound interest. Interest considerations are of little merit in determining depreciation for cost purposes, but they should be given serious considerations in estimating the value of property. The straight-line method is widely used by both public utility and other types of industries. Its basis is that the depreciable cost—the total cost ready to use less the estimated salvage value at the time of retirement—is divided into equal amounts, to be charged as depreciation expense for each of the accounting periods, usually years, during which the property is expected to be retained in use.

A variation of this straight line method, which is usually applied to years or other time basis, is to spread

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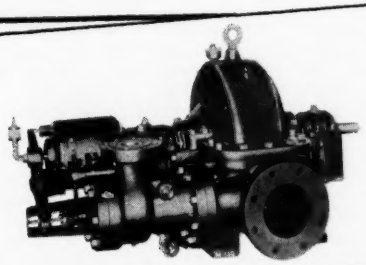

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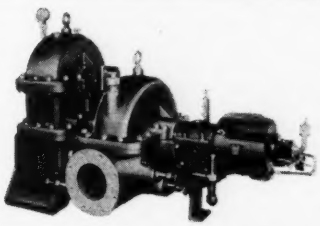

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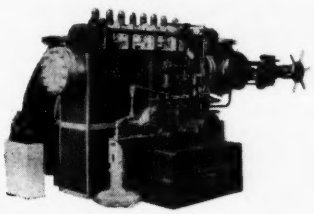

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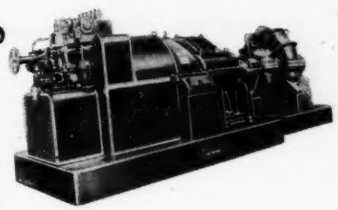

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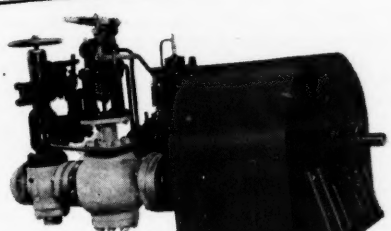

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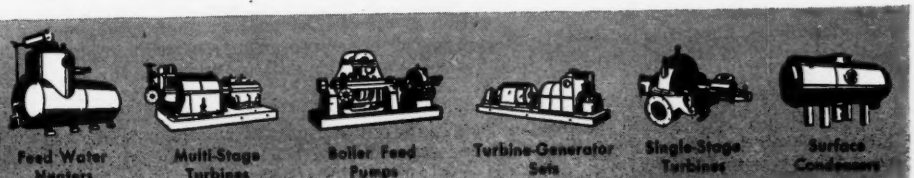


the depreciation on the basis of units of products produced. This use basis has merit in those plants wherein the useful life of the equipment is primarily determined by production activity rather than by elapsed time. Because obsolescence, in one form or other, is often the heaviest contributor of the forces causing management to retire depreciable property, it follows that the use basis is generally not as applicable as is the time basis.

One argument for adoption of the use basis for spreading depreciation cost is that it permits variations in the annual charge in accordance with business volume, thus decreasing stated profits somewhat in periods of good business and increasing them somewhat in periods of poor business, as compared to the stated profits on the basis of equal annual depreciation. The better method of the two is the one that adheres closest to the facts of the useful life of the property, and treats the stockholders and customers equitably over a period of years.

Objectives of Depreciation Rate

Objective in setting a depreciation rate should be to determine one that will recover the exact cost of the property (less realized net salvage value) over the exact useful life of the property. This is an ideal the attainment of which is seldom realized. What engineer, plant foreman, or comptroller can forecast with accuracy the exact future life and salvage value of a steam turbine now being installed? From past experience and from the experience of similar companies, it can be decided that 15 years and 10 per cent salvage are reasonable estimates with which to calculate the initial depreciation rate. Adjustments should be made in this rate just as soon as it is certain that the rate is not in accord with the probable life of the turbine.

In setting depreciation rates for the properties of industry, management must be conservative and use the maximum reasonable rate. That is, use the minimum expected probable life of the unit, or average life if for group properties. This scheme introduces a factor of safety. With new processes or new machines, it can be expected that their most productive years will be their first years and it is better to recover a large portion of their cost during these years than to postpone the recovery into the uncertain future. The competitive situation of private industry necessitates that a company be flexible, financially and physically, for it is never known when invention and discovery may render many million dollars worth of property obsolete overnight.

Use of Retirement Statistics

Power house properties, because they consist of only a relatively few units of expensive property, are not of the type on which it is easy to build up histories of life from which careful estimates of probable lives can be made. Management, as a result, must depend more upon judgment than experience in estimating the lives for depreciation purposes. With mass units—meters, poles, transformers—found in utility properties and with machine tools, motorized units, and electric motors found in industry, it is possible to study experience statistically and develop reliable life curves on which to base life estimates of existing similar properties. The usual process of analysis consists of plotting survivor curves, as illustrated in the accompanying graphs, from which the average life is calculated. The curve is also useful in estimating the probable future life (expectancy) of existing units at any age. This type of analysis is becoming of increased use in the utility field.

These curves have a secondary use in long range planning. From them it is possible to estimate future retirements of property. This estimate, in combination with a projected growth curve of the company, affords a reasonable basis of estimating the year by year purchases of the units that will be necessary to maintain the plant to a forecasted level.

Economic and Physical Lives

Nothing is mentioned in the foregoing about economic life. Service life is usually that length of time from the date of installation of the property to the date it is disposed of by the company concerned. This period is not necessarily either physical life nor economic life. Automobiles, for instance, have some four or five owners during their physical life, each owner suffering his own depreciation expense based upon his purchase and selling prices. The physical life would be the total time from purchase new to date of scrapping (or date of retirement from service). Economical life would end when the same or better transportation service could be obtained at a lower cost by buying another automobile.

As will be considered later, it is necessary to consider all elements of cost in a comparison to determine when it is economically wise to replace an existing unit with another unit. It can be said that management intends in each case to dispose of its old equipment at the end of its economic life, rather than at the end of its physical life. Whether it succeeds in doing so, depends upon the details of how this economic question is viewed, as well as upon the turn of economic events after the machine is disposed of and at all times during its ownership by the company.

In making an analysis of whether it is economically wise to replace an existing machine—a generator or a boiler—with a new unit to perform substantially the same type of service, depreciation enters the estimates of annual cost of both the existing unit and the proposed new unit. In this application, however, the amount of depreciation already taken on the existing old unit has nothing whatsoever to do with the calculation. Whether the accounting office has charged off half the cost of the unit or has fully depreciated it is ignored, and rightfully so. The correct equivalent of depreciation to consider for the existing unit is the difference in salvage value of the unit as of the present date and some future date chosen as allowing for a reasonable comparison.

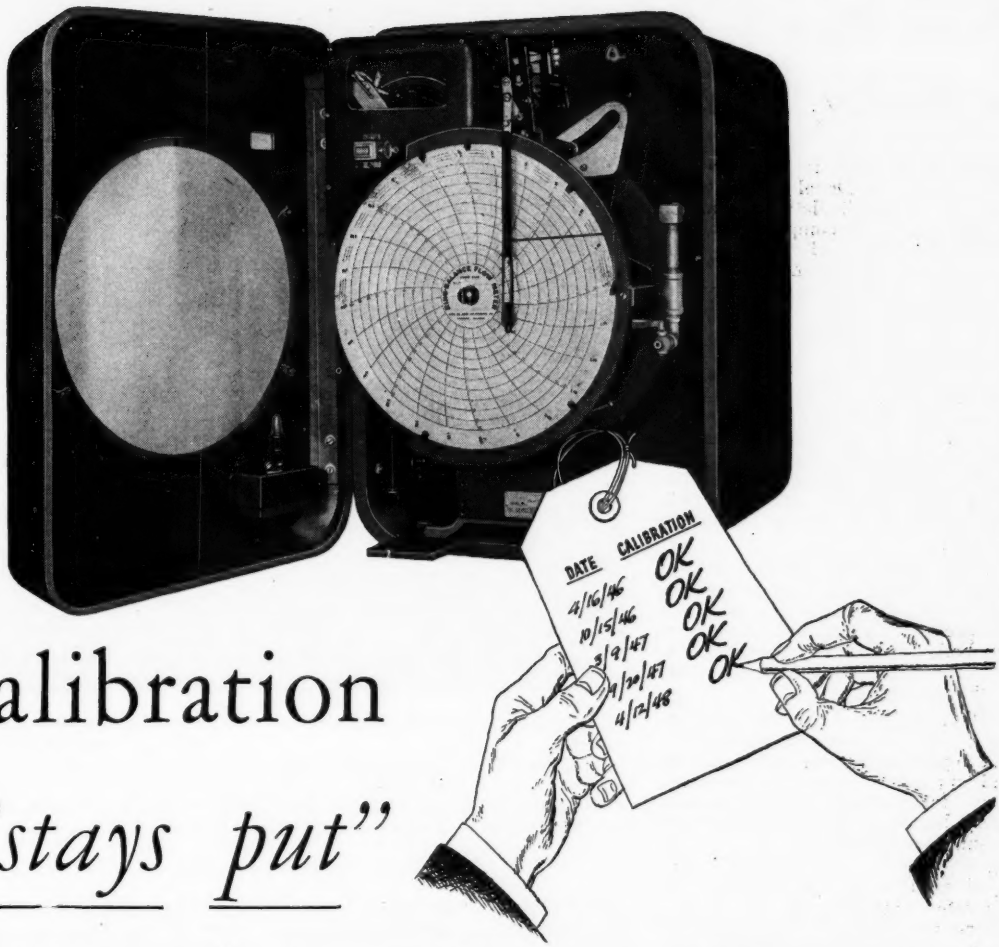
The original cost of the unit, less salvage value, became a real and fixed cost upon payment for the machine; and no amount of figuring can change this cost or transfer it to a replacement machine not yet purchased. A prospective new machine must not be burdened with unrecorded book depreciation costs of an existing machine, just because the accounting office had not made such entries in the books. It must be kept in mind that annual depreciation expense is an estimate based upon expected life of the property and that, any day, management may decide to retire the unit, whether or not the accounts indicate that the full cost of the unit has been charged to expense.

The brief example shown in Tables I and II illustrates the essential steps in a replacement study.

The savings in annual cost of $3,790 and $5,385, respectively, for the 5-year and 10-year basis, shown in Table II, amount to 12.6 and 17.8 per cent annual net return on the initial investment of $30,000. Because nominal interest is included as a cost, these returns may be considered returns on the risk involved. For this example, no decision can be given without specific knowledge of the company, its financial and competitive position, its existing opportunities for investment elsewhere in its own business, and the general trend of prices. If the machine in question is standard power house equipment, that would continue to be used whether business volume went up or down, it would be wise to install it on a much lower risk return than is desirable for a particular device or process used in producing goods of an uncertain future.

In making decisions on whether to install new machines, new processes, or new plants, management must use rather high factors of safety, or else investment in the physical plant would soon reach dangerously high levels. Prospective 10 per cent returns on proposed developments are simply not sufficient in view of the risks involved and in view of the uncertainties of the estimates upon which the analysis is based. Con-

(Continued on page 142)



Calibration "*stays put*" in Hagan Ring Balance Meters

Once a Hagan Ring Balance Meter is properly calibrated for a given set of operating conditions, you can virtually forget it. Here's why:

1. **Calibration is independent of the quantity of the sealing liquid, so long as a seal is maintained.**
2. **Calibration is not affected by changes in density of the sealing liquid due to changes in ambient temperature.**
3. **No moving parts in contact with measured fluid.**
4. **No stuffing boxes.**

Just one more feature that is influencing more and more plants to *standardize* on Hagan Ring Balance Meters.

For full information, write for Hagan Bulletin 2M48. Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN CORPORATION

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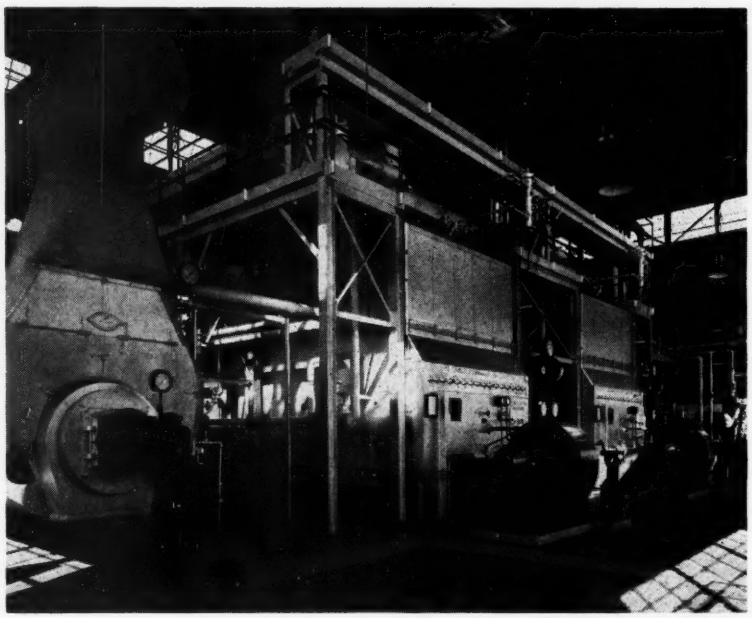
BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

Power Plant Services For New Sinclair Laboratories at Harvey, Illinois



BOILER HOUSE for the new Research and Development Laboratories of the Sinclair Refining Co. at Harvey, Ill. is compact in design, yet ample space is allowed for repair work on the equipment. Two 30,000-lb-per-hr, oil-fired boilers, shown in the accompanying view, provide heat and laboratory process steam for all of the nine buildings comprising the Laboratories. A smaller auxiliary boiler is shown at the extreme left. Meter panels next to the boilers give necessary operating data. The forced-draft fans, mounted in front of the boilers, are controlled from these panels. Fuel oil tanks are located above ground behind the boiler house.

In the background is an air compressor, which supplies compressed air to the laboratories. An auxiliary compressor is located at the rear of the boiler room. The connection to the city water main is also located in this building.

Other facilities in the building include a shop section for construction and repair of laboratory equipment and apparatus. The central storehouse for the plant is also located in the building. Heating and process steam, compressed air, and water, together with other utilities, are piped to the various buildings in concrete tunnels and trenches. Where trenches are exposed, they have removable metal plate covers which perform an added service as snowfree sidewalks.

The new Sinclair Laboratories, officially opened on October 22, illustrate the current trend toward adoption of institutional campus lines in the layout of industrial research centers.

Here nine buildings with a total of 215,000 sq ft of floor space have been grouped in one landscaped 20-acre block so that the individual units can be doubled or trebled in size without encroaching on each other or on undeveloped sections of the 38-acre site.

Eugene C. Herthel, manager of the research and development department, heads the new research center which has a staff of more than 500 technical and non-technical employees, including personnel formerly located in the laboratories at the company's East Chicago refinery.

The new laboratories were designed and built by the Austin Co. who developed the overall plan in collaboration with E. W. Isom, Sinclair vice president in charge of research. The engineering division of Sinclair's research and development department, under the direction of H. C. Kuhn and A. H. Eron, supervised details of planning and construction.

The layout includes two large inter-connected, three-story air-conditioned buildings for adminstrative and general research activities, a tall six-section pilot plant building, a 46,000-sq ft engine laboratory, plus smaller structures for distillation and catalyst activity tests, other research functions and various services.

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

FOURTH ANNUAL National Conference on Industrial Hydraulics, sponsored by Illinois Institute of Technology's graduate school and its Armour Research Foundation, was held at the Sheraton Hotel, Chicago, October 20 and 21. Victor L. Streeter, director of fundamental fluid mechanics research, is director of the conference.

Flanged Joints — Their Developments and The Trend were covered in a paper by E. G. Schmidt, Supervising Engineer, Crane Co. Severity of services on which flanged joints are used has required continued development and improvement of such joints to provide tight sealing means which require a minimum of attention. The paper illustrates the lines along which such development has proceeded in the past, and describes recent development and test work on pressure-sealing types of joints.

A comprehensive review and discussion of hydraulic seals and packings was presented by Carl E. Schmitz, Vice President-Director of Engineering, Crane Packing Co. Hydraulic packings such as "O" rings, "V" rings, hydraulic tucks, metallic, woven, and cloth inserted packings were illustrated and discussed, as well as materials used in construction and services for which each is suited, including effects of temperature, speed of shaft in fpm and rpm, factors of design necessary for successful performance, types of equipment for which packings are best suited and recent trends in industry concerning various styles and types of conventional packing materials.

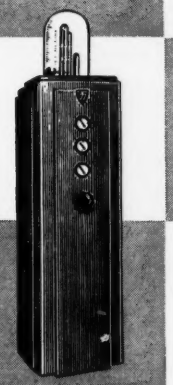
H. H. Dunkle of Johns-Manville Sales Corp., in his paper on Gasket Design and Selection described various types of gaskets which may be classified as non-metallic, semi-metallic, or all metal.

In a paper on Recent Developments in Hydraulic Turbines, J. F. Roberts, Manager, Hydraulic Department, Allis-Chalmers Mfg. Co., dealt with the design and construction of large hydraulic turbines, especially those with ratings from 10,000 hp to 125,000 hp.

Hydraulic Surges in Pump Discharge Lines were treated in a paper by S. Logan Kerr, Consulting Engineer.

The basic principles of the jet pump were covered by R. G. Folsom, University of California, in his paper Predicting Liquid Jet Pump Performance, while explaining the importance of momentum considerations in calculating the overall performance of a given unit.

FOR YOUR HEAT EXCHANGERS OR CONDENSERS, THIS W&T CHLORINATOR CAN:



- Reduce down time
- Cut operating costs
- Improve heat transfer

The machine shown is a W&T Visible Vacuum Chlorinator for the application of chlorine to cooling water circuits through the W&T De-sliming process. Its design is the result of over thirty-five years of pioneering in chlorination, plus the accumulated experience of thousands of installations throughout the world.

Because of the care put into its design and construction, this chlorinator can do these things economically and dependably:

REDUCE DOWN TIME and eliminate costly plug cleaning by ridding condenser tubes of bacterial-induced slime growths.

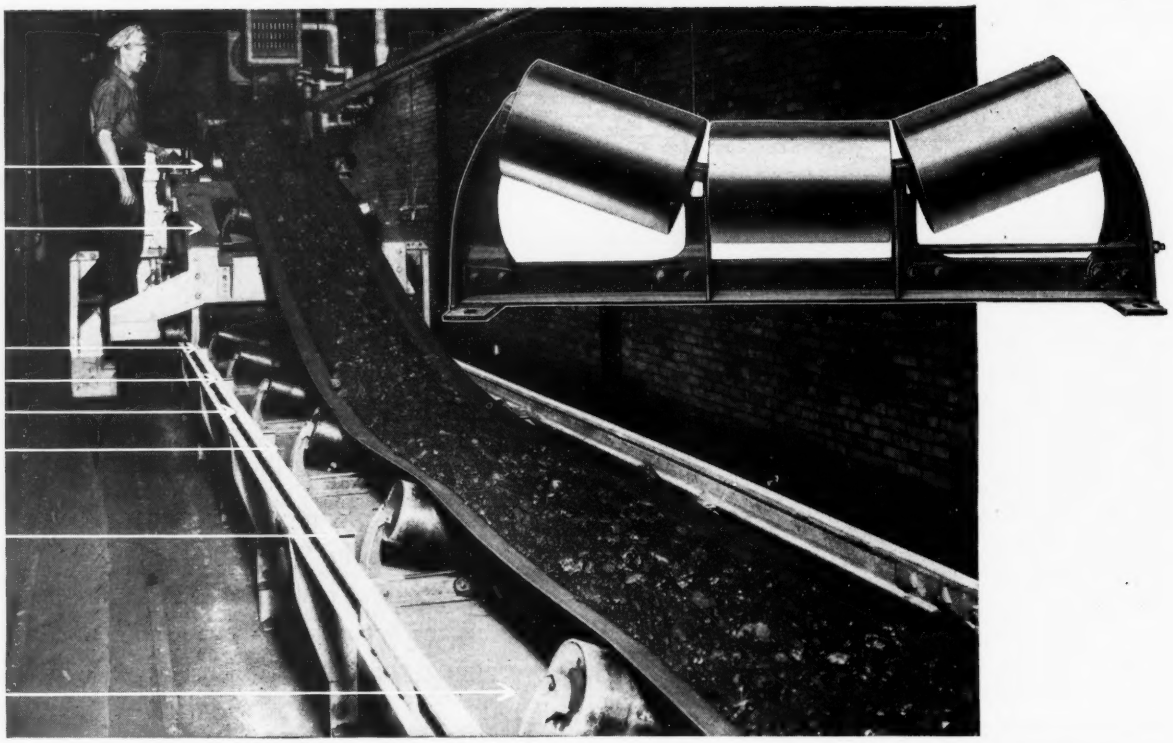
CUT OPERATING COSTS by keeping condensers and other heat exchange equipment in service longer without shut-down and, at the same time, give higher operating efficiencies.

IMPROVE HEAT TRANSFER by keeping water-side surfaces continuously protected against the formation of a slime layer.

For complete information on how these advantages can go to work for you, write today. There's no obligation.

WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

CD-30



Link-Belt Standardized Design Cuts Belt Conveying Costs

In the Link-Belt "100" series belt conveyor idlers, we believe that we have achieved the ultimate in design and performance, with evolution of engineering features progressively since 1896. These features cut conveying costs by reducing maintenance, giving longer service, and permitting the greatest simplification.

In addition to idlers, Link-Belt builds a great variety of standardized design conveyor elements and accessories such as: belt and apron feeders for uniform loading; trippers for intermediate discharge or distribution; drives using gears, reducers and chains; terminal machinery; supporting structures and enclosures.

We are at your service for complete conveyor systems, or individual equipment, to suit your requirements.

LINK-BELT COMPANY

Chicago 9, Philadelphia 40, Pittsburgh 13, Wilkes-Barre, Huntington, W. Va., Atlanta, Dallas 1, Minneapolis 5, Denver 2, Kansas City 6, Mo., Los Angeles 33, San Francisco 24, Cleveland 13, Indianapolis 6, Detroit 4, St. Louis 1, Seattle 4, Vancouver, Toronto 8.

11,212

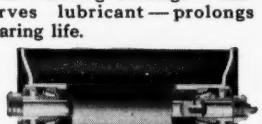
LINK-BELT

THE SYMBOL OF QUALITY — LINK-BELT

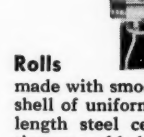
BELT CONVEYOR EQUIPMENT

IDLERS • TRIPPERS • BELTS • PULLEYS • BEARINGS • DRIVES

Grease-in—Dirt-out Seal
prevents harmful foreign matter from reaching bearings — conserves lubricant — prolongs bearing life.



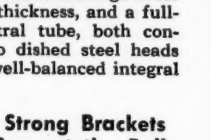
Rolls
made with smooth rounded-edge outer shell of uniform thickness, and a full-length steel central tube, both continuous-welded to dished steel heads to form sturdy, well-balanced integral units.



Strong Brackets Support the Rolls

Supporting brackets are tough malleable iron in reinforced T-section to withstand load and impact.

Interlocking Nuts and Yokes Prevent Brackets from Spreading



Impact Idlers with Rubber Treads

Interchangeable with steel rolls this type provides a Cushion at loading points to protect idlers and preserve the belt — A good investment where heavy lump materials are handled.

which pump?

When you buy a pump you naturally expect good service, dependable operation, low power and maintenance costs and other benefits. The question is—which pump will give you these benefits in greater measure?

To help you answer this question read the clear statements about our Company and our products—draw your own conclusions.

1. Warren is backed by 50 years experience in building pumps.

2. Warren builds pumps *exclusively*. Our reputation is based *entirely* upon our ability to build pumps.

3. Warren builds practically *all types* of centrifugal and reciprocating pumps and will engineer special pumps for special purposes.

4. Warren ranks well among pump builders as to size, organization and facilities.

5. Warren bows to no one in selecting the right pump for the job. "A Warren recommendation is never a compromise."

6. Our customers include many of the famous names throughout industry.

7. Warren pumps are fairly priced—but not built to a price. Initial cost is insignificant when measured against results.

8. Warren pumps are guaranteed—not only as to quality and workmanship, but also for performance as rated when shipped. Maintained efficiency is inherent in every Warren design.

Why not put your pump problems up to Warren?

WARREN PUMPS

Reciprocating and Centrifugal

WARREN STEAM PUMP CO., INC., WARREN, MASS.

Atlanta Boston Chicago Cleveland Denver Detroit Houston Manchester Los Angeles Minneapolis New Orleans New York Philadelphia Pittsburgh Richmond San Francisco Seattle St. Louis

Guard Your Power

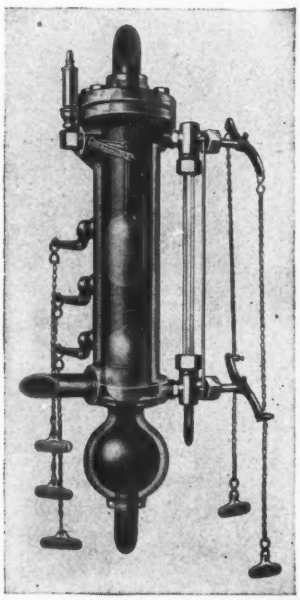
with Reliance Safety Water Columns and Gages

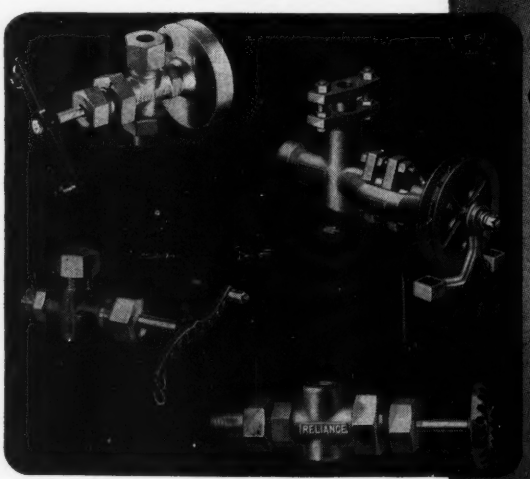
Reliance Water Columns for all pressures up to 2000 lbs.

• In spite of careful employee training and frequent warnings, low water level is still a common cause of serious boiler damage. Guard against power interruptions with ample means of checking water levels—even to having *extra* checks and signals to guarantee instant attention to approaching dangerous conditions.

Reliance Boiler Safety Devices include all the elements of safe water level supervision. Known the world over for sturdiness, accuracy and dependability, Reliance ALARM Water Columns are available for any pressure, and gage equipment to suit every water level checking need. Recently added are electric signal-actuating devices for main boiler and other water-containing vessels . . Reliance Representatives in all principal cities willingly help you to select the most suitable equipment for your needs.

Remote reading water level indication, so you can have a handy, easy-to-see gage on your instrument panel, is provided by Reliance EYE-HYE. Write for Bulletin—mention your working pressure.





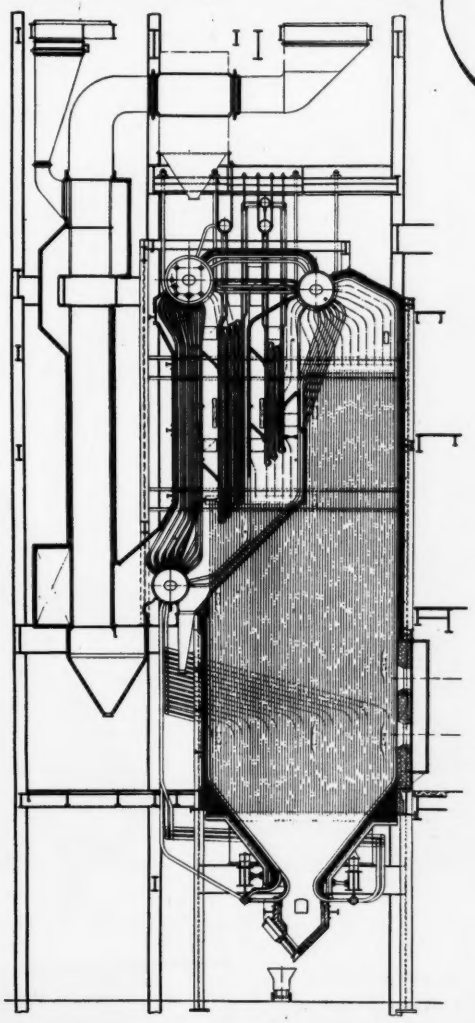
Illustrated above are four types of Reliance Gage Valves. At right (center) Prismatic Gage Insert; also single and double-window Mica-Protected Flat Glass Inserts.

BOILER SAFETY DEVICES since 1884

Reliance

THE RELIANCE GAUGE COLUMN CO. • 5902 CARNEGIE AVENUE • CLEVELAND 3, OHIO

350,000
POUNDS OF STEAM PER HOUR



Purchaser—
Minnesota Power & Light Co.

Location—
Duluth, Minn.

Number of Boilers.....1

Type of Boiler
Erie City 3-Drum
Steam Generator

Pounds of Steam/Hr. 350,000

Design Pressure....1025 PSI

Operating Pressure . 925 PSI

Steam Temperature.. 905° F.

Water Walls.....Erie City
Bare Tube

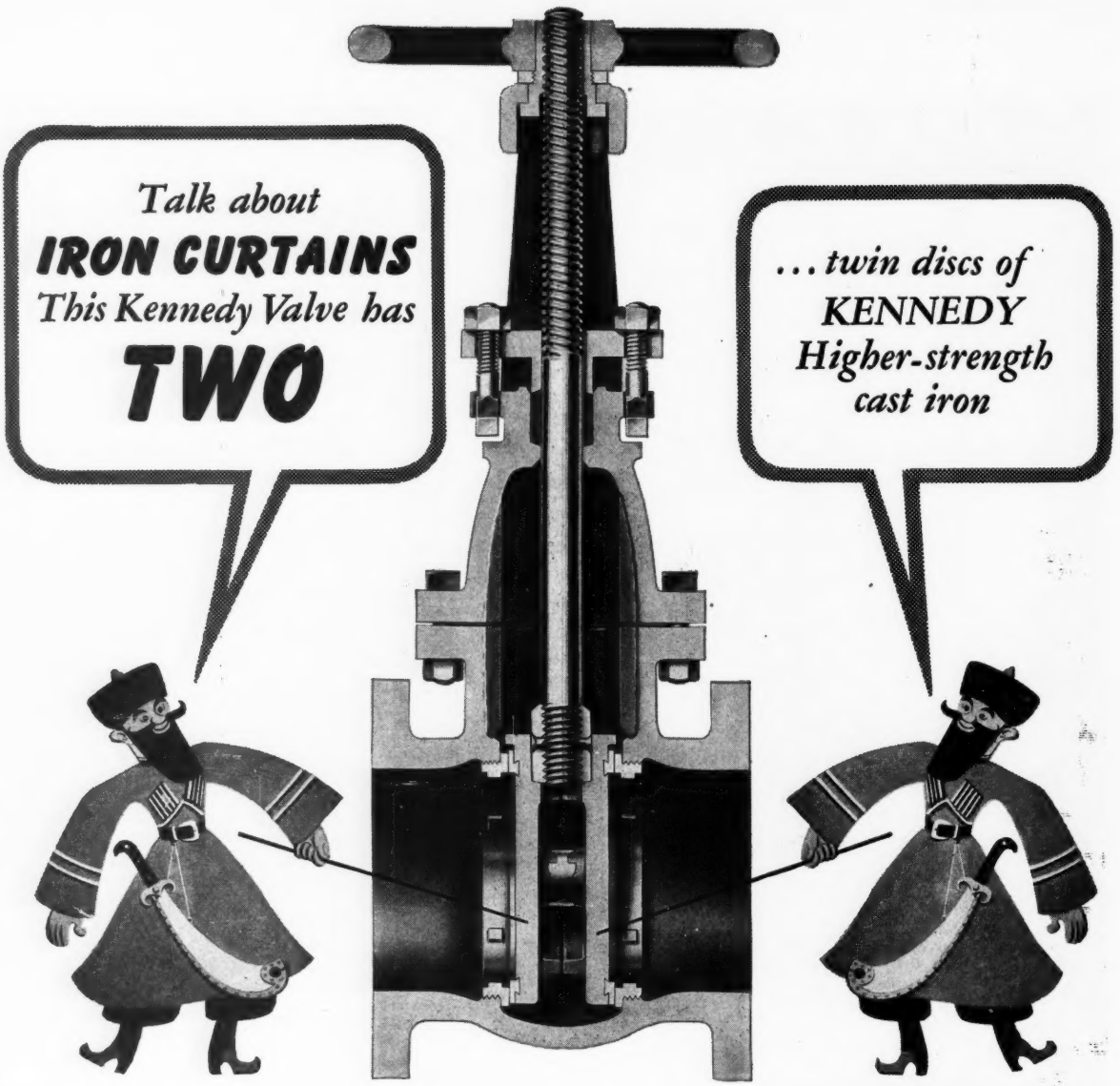
Air Heater.....Erie City
Tubular

STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY
SINCE 1840

ERIE CITY IRON WORKS • ERIE, PA.



When you close a Kennedy Iron-Body Double-Disc Gate Valve, you drop a *double* iron curtain...twin discs of Kennedy Higher-strength Cast Iron — double assurance of complete closure, even when grit is present in the liquid being handled. As soon as the port opening is completely closed, a wedging device between the discs drives them apart . . . forcing each disc against its seat. If grit is caught on one seat, the other seats tightly.

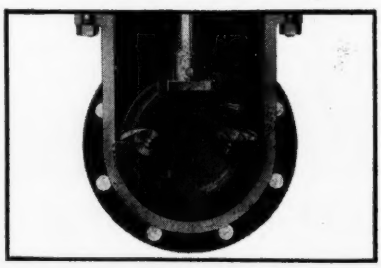
The lodgment of sediment or the position of the valve will not affect the action of the cams and discs. Operation is perfect with either disc toward the pressure.

Every Kennedy valve...Iron-Body or Bronze...gate, globe, angle or check ...is designed with equal care to give reliable performance in its particular application.

BUY FROM YOUR LOCAL DISTRIBUTOR.

THE KENNEDY VALVE MFG. CO., ELMIRA, NEW YORK

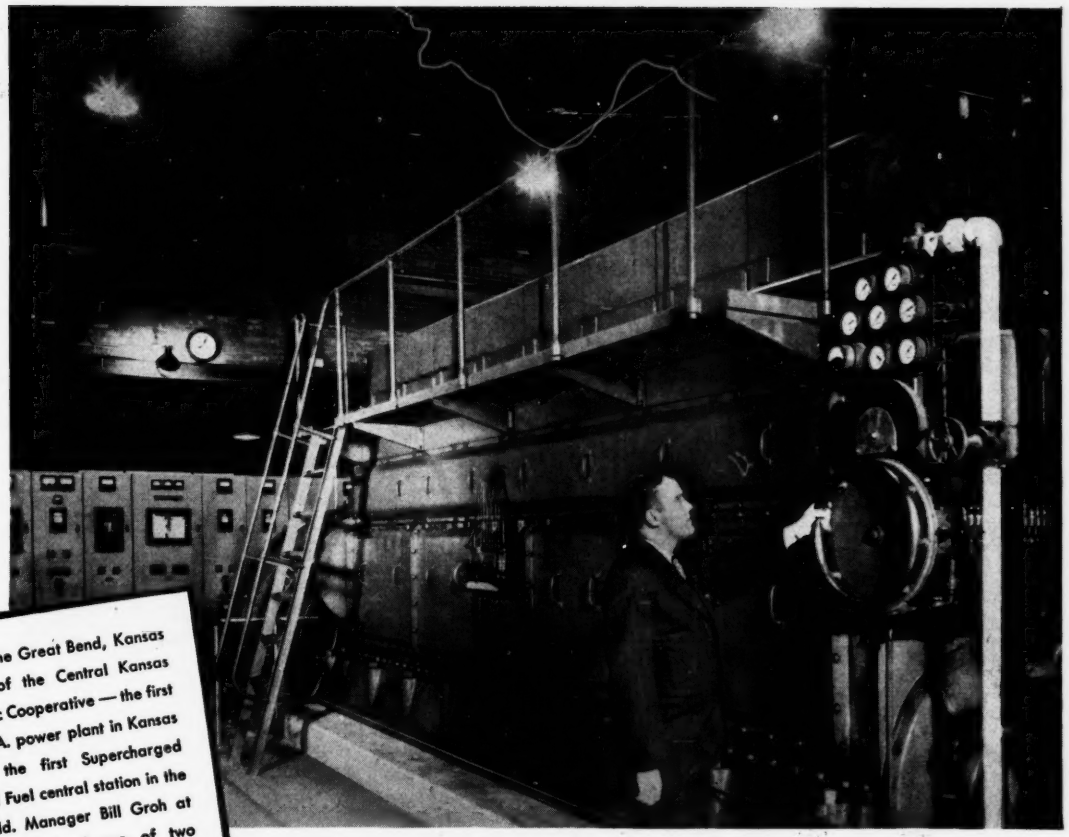
Office and Warehouses in principal Cities



Kennedy Iron-Body Double-Disc Gate Valves are available with non-rising stem or outside-screw-and-yoke, for low, standard, medium or extra heavy pressures, in a full range of standard sizes. The Kennedy 240-page catalog contains full details.

KV-177

KENNEDY valves-pipe fittings-fire hydrants



Inside the Great Bend, Kansas plant of the Central Kansas Electric Cooperative — the first R. E. A. power plant in Kansas and the first Supercharged Dual Fuel central station in the world. Manager Bill Groh at the control of one of two Worthington Type SEHGO-8 Dual Fuel Diesel Engines.

"TOTAL FUEL AND LUBRICANT COST PER KWH—$0.0015+!"

Kansas R. E. A. Station Reports Steady Savings With Worthington Supercharged Dual Fuel Diesels

One way to get the real low-down on economical generation of electric power is from a progressive R. E. A. plant. Here, in part, is what the Central Kansas Electric Cooperative Association has to say about its Worthington Dual Fuel Diesel equipment:

"Our engines have run approximately 3050 and 4100 hours, respectively, under loads varying from 300 to 1160 KW. Operation has been satisfactory at all loads.

"One remarkable point is the low lubricating oil consumption . . . Also, we have had very little maintenance work.

"The past month the total fuel and lubricant cost per KWH generated has been 1.517 mills. . . . The saving of gas over fuel oil is very great.

"A fire necessitated shutting off our gas line for 12 hours. We switched to oil Diesel operation without any interruption."

Economy In Every Detail

With Worthington Dual Fuel Diesels you get outstanding thermal efficiency on the cheapest fuel available — oil, gas or oil-and-gas in any ratio — while Worthington's long leadership in developing Diesel design and performance means additional power for every operating-dollar you spend. For further proof that *there's more worth in Worthington*, contact *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

WORTHINGTON

EG-2

YOUR PARTNER IN POWER PROGRESS

Diesel engines, 150 to 2,640 hp . . . gas engines, 175 to 1,720 hp . . . dual fuel engines, 225 to 2,640 hp.

WORTHINGTON-BUILT AUXILIARIES

Air King Compressors

Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative Type Engine Water Cooler

A New

EVERLASTING

DUPLEX UNIT

for dual safety in blow-off service

Here's an EVERLASTING valve team that's sure of a cordial reception by engineers!

This new EVERLASTING Duplex Blow-off Unit provides dual safety—plus extreme durability—obtained by coordinating the respective merits of two highly efficient EVERLASTING Blow-off Valves.

✓ Check *these combined advantages*

This is the new Everlasting Rack & Screw Valve — screwed or flanged, slow-opening type —*the sealing valve*

The Sealing Valve

✓ Unimpeded straight-through flow — at full pipeline capacity

✓ Self-grinding action of disc across seat keeps valve constantly self-lapped to microscopic precision—a drop-tight seal always assured

✓ Non-wedge construction — valve cannot jam or stick

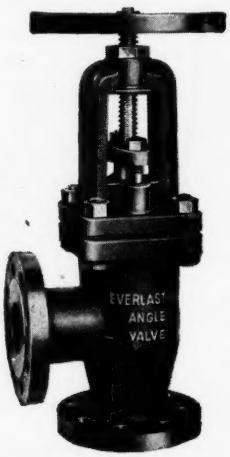
The Blowing Valve

✓ Built stoutly — to withstand shock of the blow-off force

✓ Built of tough materials — to resist erosion and abrasive action of solids in blow-off water

✓ Built without pockets — to prevent lodgement of solids

✓ Built to seal drop-tight — and stay that way



This is the Everlasting Angle Valve—*for taking the blowing force*

In dual operation these EVERLASTING Valves have what it takes to render dual safety in blow-off service . . . and they keep on doing it! And for ease of operation, positive blow-off action, drop tight seal, dependability and long life, this new EVERLASTING Duplex Blow-off Unit is unsurpassed. It has already set new standards of performance in blow-off service!

These valves fully meet all boiler blow-off code requirements. Either valve available separately.

Ask your distributor — or write directly to us—*for complete information.* EV-518

EVERLASTING VALVE COMPANY

49 Fisk Street, Jersey City 5, N. J.

Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF.

EVERLASTING VALVES give "everlasting" service!

TORTURED ON THE RACK FOR LONGER SERVICE LIFE

QUAKER PRE-TESTED PRODUCTS FOR POWER FIELD ASSURE LONG TROUBLE-FREE SERVICE

Test the finished products until they break down! That's the aim of the technical men in Quaker's modern laboratories. The results of these torture-tests are the reasons why Quaker Hose, Belting, Packings, moulded goods and other industrial products stand up so much longer in use. They're pre-tested and performance-proved!

The adhesion test shown is just one of the 18 torture-tests. Here weights are attached to the rubber section of the product for the purpose of stripping off the fabric. Tight adhesion of rubber-to-fabric is an important factor in the long-lasting quality of belting, hose and packings. Checking the adhesive qualities of rubber in Quaker products assures strong resistance to ply separation . . . prevention of product breakdown in service.

For higher plant efficiency and lower operating costs specify long-lasting, pre-tested Quaker Products. Call your nearest Quaker distributor. He and the Quaker sales engineer are teamed to provide accurate recommendations on industrial rubber products.

QUAKER RUBBER CORPORATION

PHILADELPHIA 24, PA. • New York 7 • Cleveland 15 • Chicago 16 • Houston 1
Western Territory
QUAKER PACIFIC RUBBER CO. • San Francisco 10 • Los Angeles 21 • Seattle 4

QUAKER RUBBER CORPORATION · PHILADELPHIA, PA. · QUALITY SINCE 1885 ·
REG. U. S. PAT. OFF.

QUAKER *Pre-Testing* OFFERS THE POWER FIELD

BELTING FOR MAXIMUM HORSEPOWER TRANSMISSION

Huge flat belts driving large flywheels or small fractional horsepower drives on small motors . . . Quaker pre-testing develops belts for every need of the Power Industry . . . belts to assure peak efficiency under all operating conditions.

HOSE THAT STANDS WEAR AND ABRASION

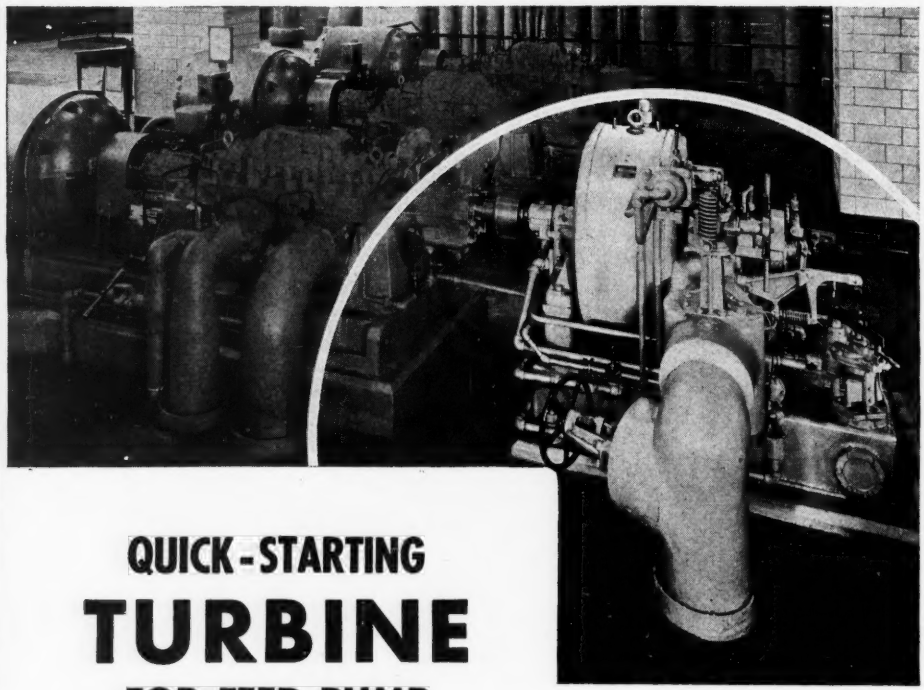
Hose for air, steam, water, oil, gas, chemical, fire or paint, Quaker makes it and makes it to fit the needs of the Power Industry . . . each length of Quaker hose is made right . . . pre-testing assures peak-performance.

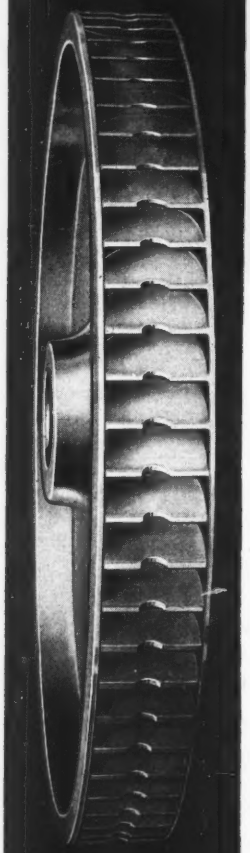
PACKINGS FOR TIGHTER SEALS . . . LONGER WEAR

Quaker packings are scientifically engineered for every use—for pumps, refrigeration compressors, water lines, valves and the many other places in the Power Industry. Each pre-tested for positive performance.

QUAKER RUBBER PRODUCTS
custom made for every industrial use

TERRY





QUICK-STARTING
TURBINE
FOR FEED PUMP
EMERGENCY DRIVE

The turbine shown at the right picks up the feed-pump load in case the motor, which normally drives the unit, is inoperative. Thus the turbine must be able to start quickly and be completely reliable—characteristics which are assured by the generous blade clearances and one-piece construction of the Terry Wheel.

This is but one example of many special turbine requirements that are met by the Terry solid-wheel turbine. Details on how this and other Terry Turbines will meet your individual needs will be gladly supplied by a Terry engineer.

DATA

The turbine is 620 hp, 3550 rpm for 850 psi, 900F steam with 2.5 psi back pressure.

Installed in the Crawford station, Middletown, Pa., Metropolitan Edison Co. Gilbert Associates, Inc. were the consulting engineers.

T-1178

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

PLANE SNIPS POWER LINE; CONTROLLER RE-ROUTES LOAD

L&N Load-Frequency Equipment Installed for Every-Day Service, Takes Emergency in Stride

This plane crash provided an unexpected test for L&N equipment . . .

. . . in the Load Dispatcher's Office, Glenwood, N. Y., which handled the emergency efficiently . . .

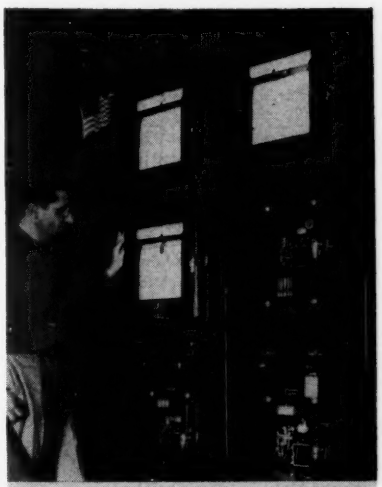
When Long Island Lighting Co. installed L&N Load-Frequency Control equipment, they were seeking principally to simplify the every-minute job of supplying power from the most efficient source.

The Control met their needs completely. It quietly directed traffic both within the Long Island system and along a tie to Consolidated Edison. It saved time, trouble, and money.

But before long a different kind of test confronted the equipment. An airplane, crashing into high voltage lines, chopped off 60,000 kw of the Glenwood Station's 145,000 kw load.

Instantly the excess output flowed along the tie. But in another instant, the Load-Frequency Controller jumped into action. It reduced the generation in quick steps. Correspondingly it cut back on the tie load. In a matter of minutes, the Station was generating only its own requirements. And power service on the station side of the break had not even trembled.

Why not investigate the possibilities of L&N Automatic Control for routine or emergency operation in your power plant?



. . . with control centralized as shown: left panel, top to bottom, Micromax Frequency Controller, Tie Line Load Controller, Master Load-Frequency Controller. Right panel, Micromax Reactive Load Recorder for Tie Line interchange, two Proportional Load Controllers.

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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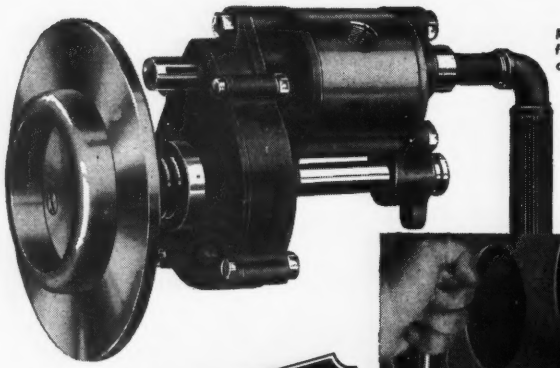
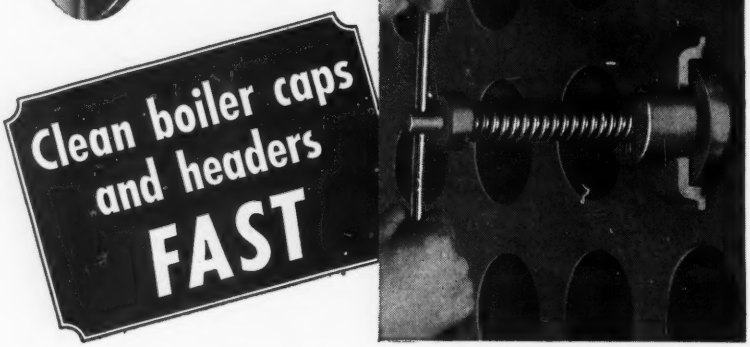


Roto Reseating Machine for boiler headers with outside caps



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Tight, leakproof joints between boiler headers and caps are quickly and easily obtained with specially designed Roto tools. These tools have been used widely for many years, and are sold on a money-back guarantee of satisfaction.

for OUTSIDE CAPS

Scale, rust or other adhering matter is removed with a Roto Reseating Machine, assuring a smooth, true fit. This air-driven machine cleans headers and caps with an abrasive cloth disk fastened to a flat surface plate whose pilot ring accurately centers the disk on the gasket seat. Caps are cleaned by securing the machine in a vise and holding the cap against the disk. Three pilot rings are furnished, one for the header and two for cleaning both seats of the caps.

The inexpensive abrasive disk is easily replaceable when worn, assuring a true grinding surface at all times. The machine is light (10 lbs) and convenient to handle. It develops 1 hp at 5,000 rpm, and is geared down 5 to 1 to provide ample torque.

Send for details and prices.

for INSIDE CAPS

Roto Hand-hole Seat Scrapers can be furnished to clean standard round and oval holes. This simple, hand-operated tool is equipped with retractable knives, mounted on the end of a revolving spindle having a bearing in a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right and the job is done. A half turn to the left releases the machine. Write for bulletin and prices.

MAKE OF BOILER	TUBE SIZE	OPENING
Babcock & Wilcox	4"	Oval
B. & W. No. 40 Header	3¼"	Oval
B. & W. No. 41 Header	2"	Oval
B. & W. Superheater	2"	Round
Babcock & Wilcox	4⅛ x 5"	Square
Casey Hedges	4"	Oval
Casey Hedges	3½"	Oval
Combustion Engineer'g	3"	Round
Edge Moore	4"	Oval
Franklin	4"	Round
Geary	4"	Oval
Heine	3½"	Oval
Heine	3½"	Round
Keeler	4"	Round
Keeler	4"	Diamond
Murray	4"	Oval
Murray	3½"	Oval
Oil City	4"	Oval
Oil City	3½"	Oval
Union Iron Works	4"	Pear Shape
Walsh & Widener	4"	Oval

ELLIOTT COMPANY-ROTO DIVISION

147 Sussex Avenue Newark 1, N. Y.

NEW PULVERIZED ANTHRACITE UNIT AT SCRANTON'S SUBURBAN PLANT

(Continued from page 59)

tifier units. These are partially manual, but are automatic insofar as the rapper controls are concerned. These permit a predetermined cycle of rapping operation for both discharge and collecting elements to be set up and maintained until changed.

(f) Operation of the blower supplying air under the cinder bed, the clinker grinders, and the ash feeder trays are all local manual. There are possibilities that, as experience indicates, these controls may be centralized and partially automatized to obtain further possible benefits in the way of better operation with less expense.

(g) The ash disposal system controls are of the local manual type and are located adjacent to the equipment in the boiler area. Operation of some integral parts of the system is automatic within the system.

(h) The cinder return system control is partially local manual but with integral automatic collector unloading, on a timed cycle. These controls are located adjacent to the equipment served in the boiler area.

(i) The boiler soot blowing system, furnished by Diamond Power Specialty Corporation, is of the steam-blowing, air-operated type and includes a remote automatic sequencing control located at a convenient point in the boiler room.

General

A broad view of the foregoing description of the features of Scranton's new unit gives further positive indication of the increasingly greater importance or higher efficiency in the utilization of fuel and labor, in spite of the considerably greater equipment cost involved. The continually rising costs of fuel, even the low grade by-product and refuse coal involved in the design of this plant, leave no other logical alternative than to design for much higher levels of performance and availability than heretofore considered practical and justifiable.

The inclusion of specific means for returning and re-burning of fly-ash, having appreciable carbon content in an anthracite furnace, as described herein, is a new and untried approach to the problem of recovering the substantial loss heretofore considered inherent in firing of this type. Its operating record should be of vital interest to many.

The authors express their appreciation for the excellent cooperation of their associates and collaborators in the development of this record. The installation bears testimony to the foresight and ability of the three major parties involved; namely, The American Gas and Electric Service Corp. as Engineers and Constructors, Foster Wheeler Corp. as Designers and Builders, and The Scranton Electric Co. as Owners and Operators.

REFERENCES

(1) "One Thousand Degrees F . . . A New High in Steam Temperature." By Philip Sporn—"Electrical World" August 17, 1946.

(2) "Burning Pulverized Anthracite in Steam Power Plants." By C. H. Frick—Transactions of A.S.M.E. May, 1942.

(3) "The Direct Firing of Pulverized Anthracite Silt." By Martin Frisch—Transactions of A.S.M.E. April, 1936.

ANOTHER LEADING PUBLIC UTILITY SPECIFIES . . .

View of boiler front from air-conditioned Control Room in the efficient and modern Industrial Canal Station of the New Orleans Public Service. Shown here are six of the 18 modern Peabody H-26 Combination Gas and Oil Burners installed in this new plant.

PEABODY BURNERS TO FIRE NEW PLANT OF NEW ORLEANS PUBLIC SERVICE

Peabody Equipment has served New Orleans Public Service and other utility leaders for more than 20 years.

One of America's newest and most efficient power-generating plants is the new Industrial Canal Station of the New Orleans Public Service. Eighteen modern Peabody H-26 Combination Gas and Oil Burners are installed in this plant to handle 90,000 lbs. of oil or 1,597,000 cu. ft. of gas per hour, *interchangeably*, and generate more than 1,200,000 lbs. of steam per hour! At this high fuel-firing rate, maximum efficiency is imperative — that's why New Orleans Public Service, like other leading Public Utilities, specified Peabody Burners . . . the standard of efficiency for more than 20 years.

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580 FIFTH AVENUE • NEW YORK 19, N.Y.
Manufacturers of all types of combustion equipment, direct-fired air heaters, gas scrubbers, coolers, and absorbers.
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1. **EVERY DART . . .** is precision-machined to a true ball joint . . . then spherically ground to give wide, true-bearing surfaces. Reason why Darts fit snugly without excessive wrenching . . . are always leakproof.

2. **EXTRA-WIDE BRONZE SEATS . . .** resist pitting, electrolysis and corrosion . . . stay drop-tight.

3. **EXTRA-HEAVY SHOULDERS . . .** shrug off wrench abuse through dozens of installations.

4. **PRACTICALLY INDESTRUCTIBLE . . .** body and nut of air-refined, high test malleable iron resists stress, stretching and wrenching . . . ensures that connections will stay tight.

See your supplier today about these outstanding, money-saving features of Dart Unions.

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PROVIDENCE 5, RHODE ISLAND

DART
UNIONS

WILL TOMORROW'S EXECUTIVES BE ENGINEERS?

(Continued from page 53)

eminently qualified for broader responsibilities.

However, by its very nature, engineering attracts individuals who seem to find this broadening effort difficult. Engineering students frequently are people of precise mental habits. Their intense interest in their chosen field produces a marked tendency toward clannishness.

Similarly, most of today's engineering training accents preparation for strict engineering application with little or no attention given the broader aspects of business administration. New types of engineering—the increased specialization of the engineer — have stampeded some schools into pouring more engineering courses into their curricula. As a result, in many instances, not even the status-quo—unsatisfactory as it may be—is maintained, but instead, what few elective subjects engineers have had in the past are being supplanted by more engineering classes

Finally, industry must not be guilty of limiting the possible achievements of the engineer in the management field. The engineer doing exemplary work in the laboratory or in the development field must not be prejudiced in his opportunities to accept new responsibilities because of the value of his work in his engineering position.

Well, then, what can we do about it?

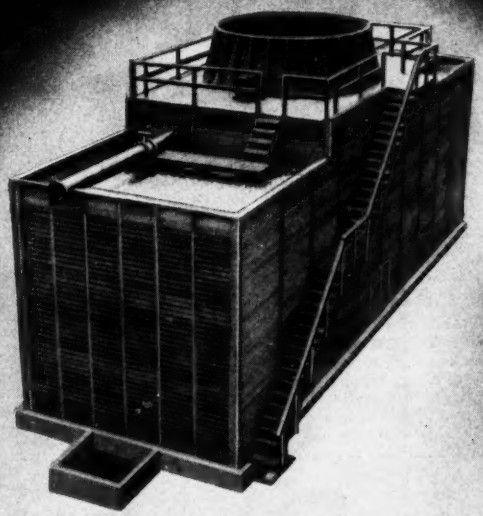
In the first place, we should realign our sights—give a new set of standards to tomorrow's engineer. The miracles of modern living are a tribute to yesterday's engineer—the man who was asked only to create them. If we can show that an engineer can provide even greater service in the future by expanding his activities beyond the pure engineering field, I feel sure that the student of today will accept this challenge and meet it as successfully as did his technical ancestors.

Because you *are* honor students there is reason to feel that you may be drifting into harmful detachment. Honor standing usually indicates diligent study; and diligent study, in turn, frequently leads to aloofness. Understand me—I am not discouraging application. Engineering cannot be absorbed by an occasional exposure to textbooks. It requires study—serious study!

But I believe there is a fine balance between serious study and the more nebulous advantages which come from collateral interests and participation in broader activities.

In moderating the training an engineer receives, colleges and universities can make even more valuable contributions if they will re-examine existing courses and realign subjects to meet the expanding needs of the engineer. I believe the progress in

Specify MARLEY Double-Flow



FOR SAFE OPERATION AND MAINTENANCE

STAIRWAY . . . DOUBLE-FLOW towers are equipped with a stairway built at the enclosed endwall of the tower. This eliminates fog envelopment and ice formation on stairways or ladders built over louvered sections. Operators do not have to climb high, dangerous ladders.

HANDRAILS . . . stairway and wide, level fan deck are guarded with high handrails. At no time is the operator at the mercy of high, gusty winds or in danger of inadvertently falling off the tower.

OUTSIDE WALKWAY . . . a short stairway leads to a walkway over each distribution basin. Water level may easily be adjusted or the basin cleaned. Complete flexibility of operation or maintenance is a result without the usual risks and dangers involved.

INSIDE WALKWAYS . . . through the interior of the tower, walkways enable the operator to observe water breakup, condition of structure, and operating conditions of the tower. This can all be checked while the tower is in operation without danger to the operator.

WALLED FAN CYLINDERS . . . each fan is enclosed with a fan cylinder . . . high enough for safety, low enough for easy inspection. And, there is plenty of room between the cylinder and fan deck railing for free movement without risk.

Tower owners and operators know that MARLEY DOUBLE-FLOW towers are SAFE TOWERS . . . safe in any stage of operation or maintenance . . . safe in any weather.

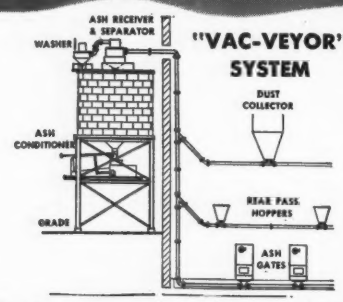
That's why more and more Safety Engineers of America's great industries are recommending MARLEY DOUBLE-FLOW COOLING TOWERS.

Ask for a MARLEY Factory-Trained APPLICATION ENGINEER to tell you more about the MARLEY DOUBLE FLOW Cooling Tower and its numerous SAFETY FEATURES. He'll be glad to help you solve YOUR [illegible]

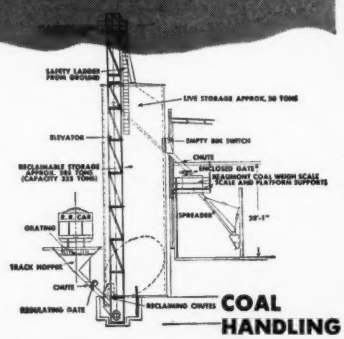
MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

Profits Saved AT EVERY STAGE . . . WITH BEAUMONT COAL & ASH HANDLING EQUIPMENT

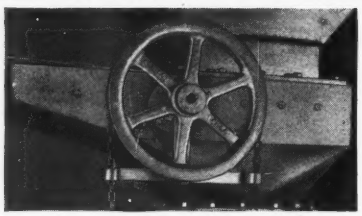


In this system, ashes, siftings, soot and dust are conveyed by pipe from the ash pits, dust collectors, stack, etc., to an ash receiver and separator at the top side of a silo—by means of a vacuum. One man operates the system, keeping your plant cleaner with less labor.



COAL HANDLING

Coal arrives by rail, is dumped into hopper, raised by bucket elevator and discharged either into bunker for immediate use or down chute to yard storage. One operator controls all equipment.

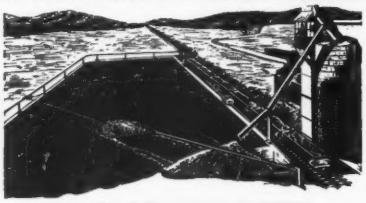


ROLLER BEARING GATE

Incorporating double rack and pinion for granular or powdered materials, these drip-proof self-cleaning gates will not corrode, bend or warp. Material cannot collect in back of gates—these ball bearing gates operate manually or electrically without strain or ramming.

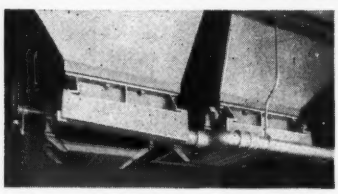
AUTOMATIC WEIGHING SCALE

Accurately weighs coal and similar materials from 1 to 60 tons per hour. Vibrating feeder plate eliminates belts, pulleys and motors. Scale is totally enclosed, dustproof and quiet.



DRAG SCRAPER SYSTEM

Coal is dug evenly with minimum power consumption. Tail blocks can be slung between posts and moved by hand, mechanically moved on I-beam track by tail block car, or suspended from aerial bridge system. One man can operate entire system by remote control.



ASH HOPPERS AND GATES

Steel plate ash hoppers are low cost, rigid, unbreakable, watertight and, when lined with refractory material, resist temperature and erosion. Ash gates are designed for use on stoker and pulverizer ash hoppers where water sealing and draining is essential.

Beaumont engineers design and erect this and associated equipment—*a complete coal and ash handling system.* You save in installation as well as in handling. ONE CONTRACT—ONE RESPONSIBILITY—FOR BULK HANDLING SYSTEMS. Write for more information to:

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Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEM

this direction being made right here at Hopkins and at some other leading engineering universities is a bright note for the future.

The Hopkins policy of a thorough grounding in such basic engineering subjects as mathematics, chemistry, and physics, while emphasizing the importance of English, public speaking, psychology, philosophy, and other cultural subjects, represents a realistic approach to our problem.

What industry wants from the engineering schools is an adequate supply of young fellows well founded in mathematics, the natural sciences, and basic engineering, but also schooled in the bare elements of political science, economics, finance, commercial law, business, etc. Not specialists in each of these fields—just active fellows with a good well-rounded education, well slanted toward engineering.

While I feel that the present educational system does a fine job of training research men, teachers, and engineers for advance development, I think the college can help industry's engineer in another way. To close the gap between the classroom and industry, the importance of having the undergraduate and the teacher work in industry can hardly be over-emphasized.

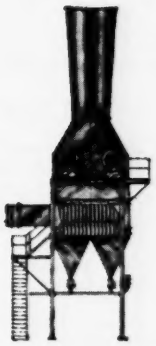
And finally, what can industry do? In the first place, the trend toward acceptance of the engineer as good executive material is increasing. Engineers who have the additional qualifications necessary for management responsibility are setting a successful precedent which will accelerate the progress of their younger colleagues.

Then, too, industry has recognized its responsibility when it requests a broad-gage educational program for engineering undergraduates. It is fulfilling this obligation with an inclusive program of student recruitment, and following along with what amounts to industrial "post graduate" courses.

Although I agree that academic post graduate work is essential for the research engineer and the teacher, I feel that for the industry engineer, this actual training in industry is superior.

What I do want to stress is that today the engineer faces new horizons. He can be of service not only in his profession but also in the major administrative posts of industry. Although progress has been made, it is up to the engineering student, the college, and industry to see that today's engineer is qualified to fulfill his destiny. If all of us do our jobs well, we know who will be tomorrow's executives.

SMALL LINES sometimes become so tightly clogged that they cannot be blown out with air pressure. A discarded speedometer cable can be used effectively in this case.



The Secret of CONTROL

Thermix Fan Stacks produce a definite controlled degree of draft—because in a unit packaged design they combine, (1) the induced draft fan, (2) the breeching connecting the fan and stack and (3) the stack itself. All *three* are interdependent and affect the controlled, overall operation. To design, engineer and purchase these parts separately would not produce the same accurate, known results that this packaged unit offers.

And what about Tubular Dust Collectors? Thermix offers multiple small diameter tubes for high centrifugal force and resulting efficiency, plus the added advantage of smaller space requirements and more accurate dust control for your plant.

A call to the field engineer nearest you will place at your disposal a specialist in the field of flue gas control.

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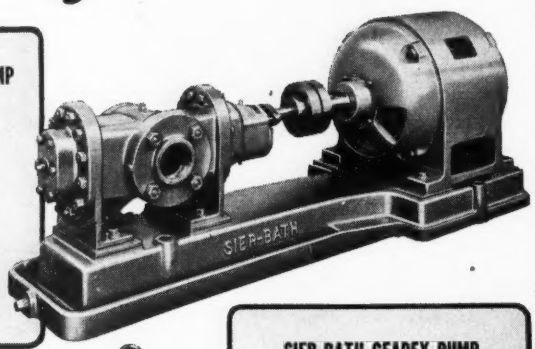
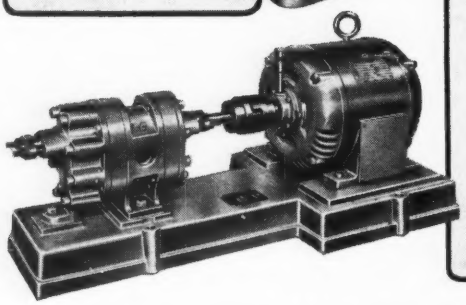
ONE PUMP working on the job is *worth a dozen* in the repair shop!

SIER-BATH SCREW PUMP

Advantages: • pulseless flow • anti-friction bearings • vibrationless operation • low maintenance cost • rugged construction.

Pumps: Acetate, asphalts, brines, Bunker C Fuel Oil, Cellulosics, Greases, Molasses, Syrups, Lube Oils, etc.





SIER-BATH GEAREX PUMP

• Balanced Axial Thrust • Pulseless Flow • Vibrationless Operation • Roller Bushings for Precision Running under load.

Pumps: Oils, Varnishes, Solvents, Molasses,, Chemical Solutions.

Capacities: 1-550 g. p. m.

Discharge: 250 p. s. i. for medium or high viscosities. 50 p. s. i. for water.

The most notable point about SIER-BATH Screw Pumps and Gearex Pumps is their relative freedom from maintenance.

THERE is no mystery about the ability of Sier-Bath Pumps to stand up under the most trying conditions. After all, in such pumps, the worms and gears are the most important parts. And when you consider that Sier-Bath Pumps are made in the best equipped precision gear shop in the country, it is easy to understand their exceptional dependability. Their pulseless flow and vibrationless operation greatly reduce maintenance cost—there is much less wear on valves, couplings and other fittings. Pipes and joints remain tight. With labor costs at their present high figures, these are important points to consider in pump selection. Send for descriptive booklet.

ALSO MAKERS OF SIER-BATH PRECISION GEARS

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Sier-Bath GEAR and PUMP CO., Inc.

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THE CONDUCTIVITY TEST

(Continued from page 62)

blowdown are suspended solids or the dissolved solids such as alkalinity, silica and total dissolved solids concentration. Once the factor limiting boiler water concentrations is determined, it is possible to control this factor within pre-determined limits by knowledge of the relationship of this substance to other substances in the boiler water.

For example, assume that at a certain plant it was determined that silica was the limiting factor and should not exceed 100 ppm in the boiler water. Through laboratory analyses it is possible to calculate the concentration of other substances in the boiler water when silica concentration reaches 100 ppm. Thus, while the control of blowdown could be determined by the silica test, for the sake of simplicity, control is usually based on the chloride test or the conductivity test. Since alkalinity concentrations can be varied by the internal treatment, it is customary to maintain a separate control for this factor.

The conductivity test provides an accurate and simple method of blowdown control. However, certain limitations must be taken into account. While the conductivity test measures the total ionic concentration, the hydroxide ion (alkalinity) has a much higher conductance than the other ions present such as sulfates and chlorides. Thus, for accurate results, the sample must be neutralized before the conductivity test is made. In many plants the alkalinity concentration remains relatively stable and blowdown control sometimes can be based on the relative conductivity of an unneutralized sample.

For accurate results, however, a boiler water sample should be neutralized before the conductivity test. Until recently, this neutralization was usually made to the phenolphtalein endpoint with sulfuric acid, converting the hydroxide ion to the sulfate ion and thus eliminating the exceptionally high conductance due to the hydroxide ion. Care must be taken in this neutralization step since slight over-neutralization will materially effect the conductivity.

Gallic Acid for Neutralization

A recent development has been the use of gallic acid in the neutralization step. Gallic acid is an organic acid and does not ionize or change the conductivity to any appreciable extent. Thus, with the use of gallic acid, the hydroxide ion is neutralized and an excess of gallic acid will not effect the conductivity to any significant extent. In addition, gallic acid is particularly convenient to handle since it is a solid material. Hence the neutralization can be accomplished simply by adding a measured amount of gallic acid by

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HOT-FLOW® SOFTENER CONVERTS WATER STEAM CHEMICALS INTO *SAFE* BOILER FEED WATER

1. Accurate and Uniform chemical feed.
2. Complete chemical reaction.
3. Adequate sedimentation.
4. Long filter runs and long filter bed life.

YOUR ANSWER IS IN THIS EXCLUSIVE DESIGN

Infilco Hot-Flow® Softener tank is divided into two compartments of equal volume. Chemicals and heated raw water are mixed in the upper annular section above a stilling plate. Chemical reaction is completed as the mixed chemicals and water flow slowly around and downward in the annular section. At the bottom, treated water separates from the precipitate and rises in the central cylindrical uptake to the takeoff, while the sludge settles to the bottom of the tank.

MAXIMUM Water Treatment • MINIMUM Chemical Cost

Water Conditioning and Waste Treating Equipment

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FIRST for Over FIFTY YEARS

Write or Call nearest Field Engineer or Chicago Headquarters

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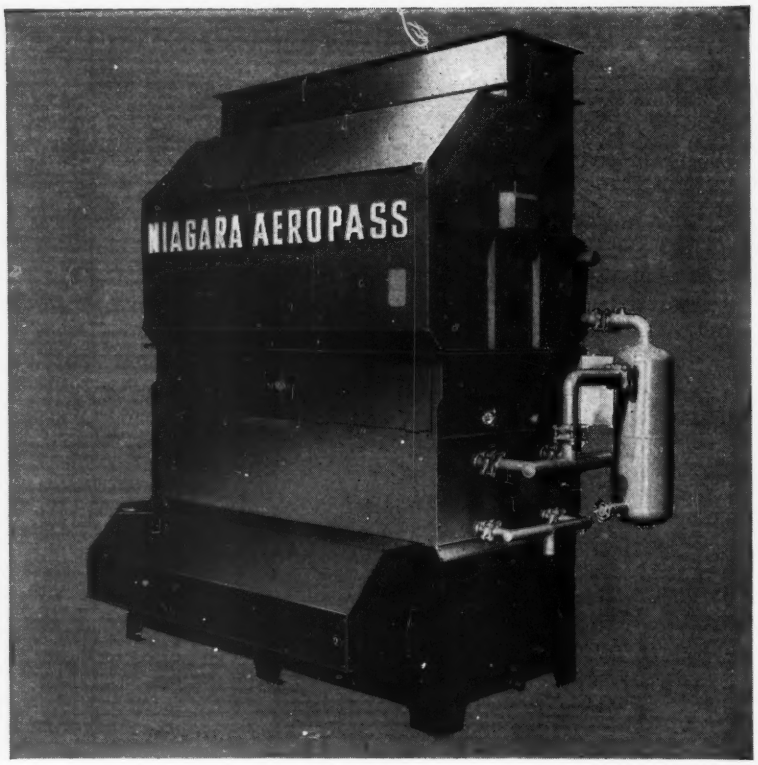

New Condenser Cuts Refrigeration Costs Saves Cooling Water

● The Niagara Aeropass Condenser cuts the cost of refrigeration by running compressors at lower head pressure, saving up to 35% of power. It uses no cooling water.

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means of a small measuring cup. This gallic acid neutralization is to be favored, particularly in the hands of non-chemical operators, because of the simplicity and accuracy of the neutralization step.

The procedure is as follows; using approximately 50 ml. of sample, add two dippers of gallic acid (0.2 grams) (see Fig. 3). Read temperature and set compensation dial on instrument (see Fig. 4). Read conductivity direct from instrument (see Fig. 5).

The relationship between specific conductance and dissolved solids content of a boiler water depends upon the ratio of the various ions in the boiler water and this will vary slightly from plant to plant. A reasonably accurate average value, determined over a wide range of operating conditions is that one micromho of conductance is equivalent to 0.8 ppm of dissolved solids with sulfuric acid neutralization, and 0.9 ppm of dissolved solids with gallic acid neutralization.

The relationship between micromhos and dissolved solids can be individually established for each plant by determining both the conductance and the dissolved solids content of a series of approximately 10 samples taken over a two week period.

Types of Installations

As previously mentioned, conductivity instruments are available for all types of installations and needs. Simplest and most common use for the conductivity test is as a daily spot check for steam purity or for control of boiler blowdown. The conductivity instrument is usually of the small portable type such as shown in Fig. 5.

Another type of installation is the use of a conductivity controller. In this case, the conductivity instrument is permanently mounted and a sample of boiler woter or steam is first cooled in a cooling coil or similar device and the sample then flows to the conductivity cell. The controller type instrument is set at a pre-determined conductivity. If the conductivity exceeds the setting on the instrument, a warning such as a bell or light is actuated. This type of istallation has been applied to return systems where serious contamination can occur. In such cases, the conductivity controller can actuate a solenoid valve discharging the contaminated condensate to waste, thus preventing it from entering the boiler where serious damage may occur.

Finally, where a permanent conductivity record is desired, a conductivity recorder can be employed. These instruments in addition to recording can also be equipped with a controller device to give a warning or operate a valve at a pre-determined value. Since conductivity cells usually cannot stand temperatures in

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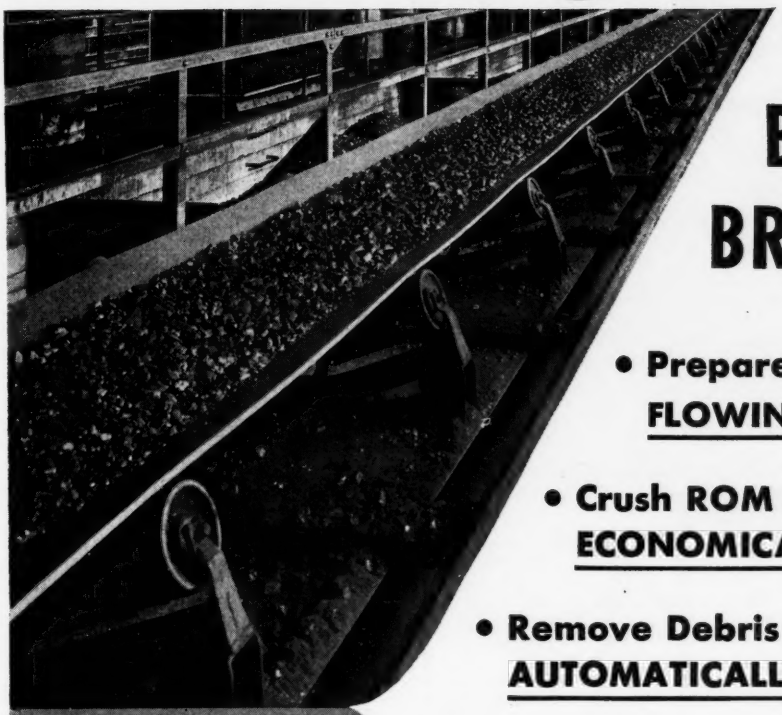

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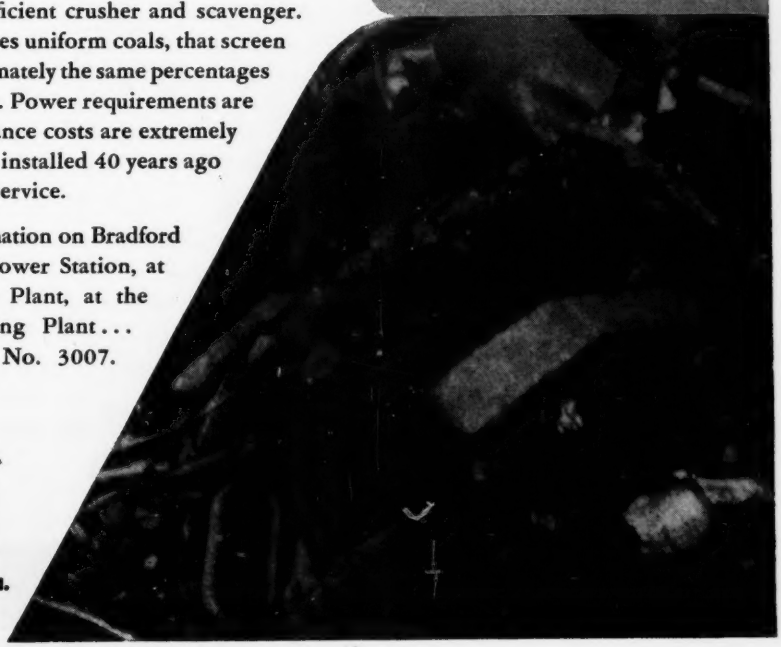

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TUBE CLEANERS

excess of 180 to 200 F, a cooling coil is employed to cool the sample o boiler water steam or condensat prior to the cell. Where the recorder is to be used to continuously measure steam purity, a Straub Degassing Condenser, Fig. 2, is usually recommended ahead of the recorder, since this condenser removes the gases of ammonia and carbon dioxide as well as cooling the sample so that a true reading of steam purity is obtained.

In addition to the use of the conductivity test in power plant operation, this test also has many applications in specific industries to control purity. Typical applications are the measurement of concentration of free caustic in detergent solutions, the measurement of free acid concentration in acid pickling baths, checking purity of distilled or demineralized water, checking completeness of rinsing and washing, and measuring the extent of a reaction.

THE DESIGN OF AN ATOMIC REACTOR

(Continued from page 73)

passages, size and location of fuel channels, the purity of the moderator, the purity of the uranium, the power and power history of the reactor, the history of the fuel units, the reactor temperature and a number of other factors. The selection of the moderator would be the result of a similar study. This sounds like a complicated program and it is. These are the kind of studies that require cooperation on the part of physicists, engineers, and chemists. Studies as complex as this give complex answers and if any progress is to be made some simple rules of guidance are needed. In general, the essential principles are the availability and cost of moderator, the amount of fissionable material required, and the behavior of the materials within the reactor under operating conditions. Also as everyone experienced in development work well knows, experiments are required to verify even the *most* elaborate and careful calculations.

As a matter of fact a great deal of the study of the various interrelations has been done by the cooperation of engineers and physicists. Already a few experiments have been made and more have been proposed. Studies, designs, and experiments need an objective. The objective of building and operating an experimental atomic energy reactor for power is a strong enough incentive to push the necessary study and experiment along. It should be remembered, however, that team work is required and the skill of the engineer in reducing things to practice and *building* must have its proper place.

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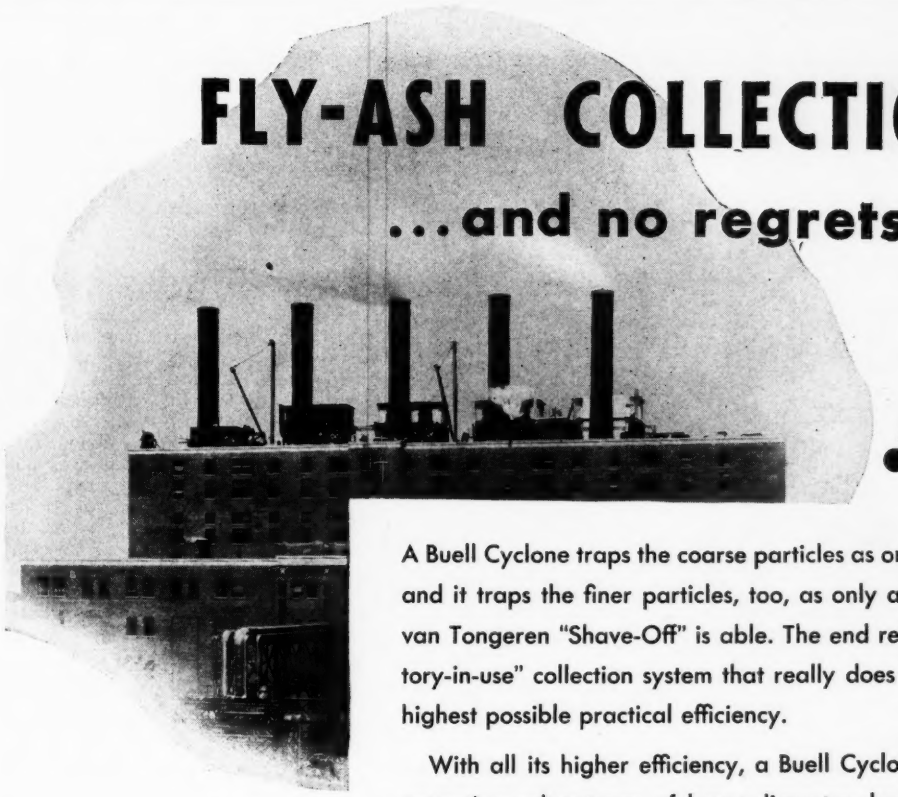

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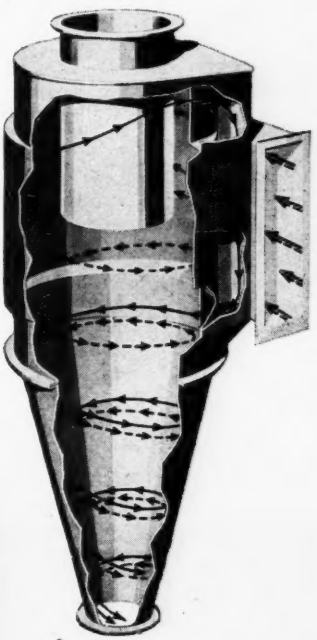

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PROTECTION OF BELT CONVEYORS

(Continued from page 103)

operating under the sub-zero conditions, frequent, for example, at Grand Coulee and in Alaska, where real difficulties are experienced. When the material contains moisture, the particles carried on to the return idlers immediately freeze solidly to the cold metal and build up. In one installation in the iron range, handling very wet material, the operators finally had to run steam pipes through the conveyor gallery to keep going late in the fall. In explanation, free moisture can exist in sub-zero temperatures only when digging out of a bank below the frost line. Rubber disc return rolls should help.

Paul Suloff of the Goodyear Tire and Rubber Co. has made cold box tests of conveyor compounds and belt samples at temperatures as low as 40 F below zero, from which he concludes that belts will remain operable at 20 F below zero. He too found that the current rubber belts stiffened much less than synthetic belts.

ELLIOTT OXYGEN SYSTEM

(Continued from page 105)

temperature heat losses and insulation losses. A small portion of the nitrogen also removes impurities in the heat exchangers as noted above. The bulk of the nitrogen is available, as shown, at about 99.5 per cent purity. Turbine-driven nitrogen compressor (19) is the principal power consuming unit. It compresses a portion of the dry clean nitrogen gas to about 93 psia and recycles it to the process for reflux and refrigeration.

The system can make both high-purity and low-purity oxygen simultaneously. The condensing of nitrogen in this reboiler provides the heat to boil off the high-purity oxygen product and the vapor loading for the operation of the column.

This combination of functions in the Elliott cycle makes it possible to obtain an unusual degree of flexibility in operation. The plant can deliver any quantity of product required over a wide range of variable conditions within the design limits of the plant while maintaining constant purity irrespective of weather conditions, seasons of the year, and other factors which effect the performance of a low-temperature process. The various functions will automatically adjust themselves to the lowest horsepower per unit of oxygen product. The plant can operate down to approximately two-thirds of full capacity without any sacrifice of horsepower per unit of oxygen product.

There is a long history of explosions in oxygen plants resulting from the accumulation of acetylene from

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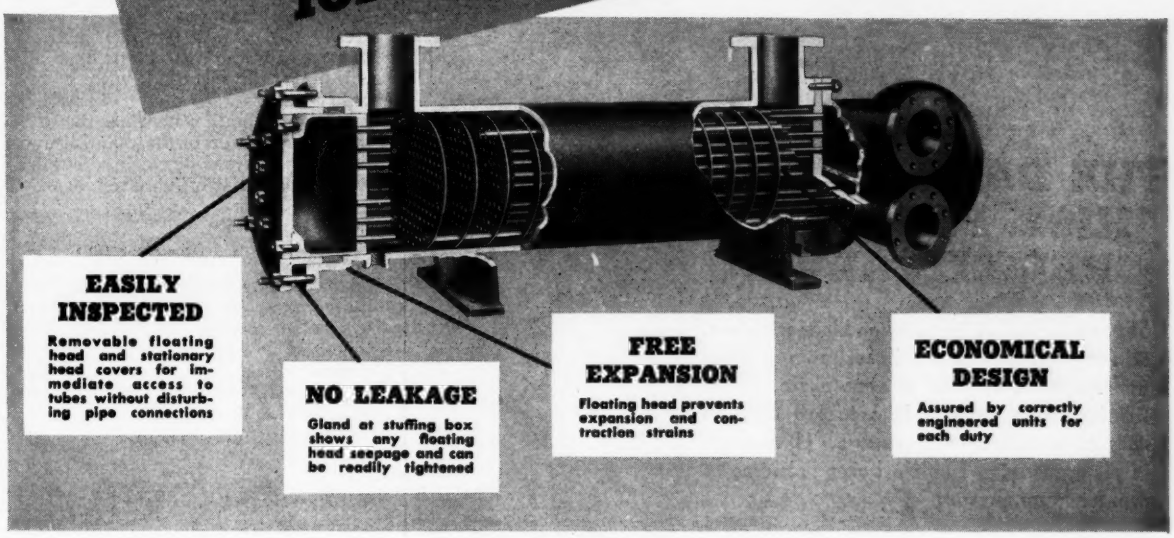

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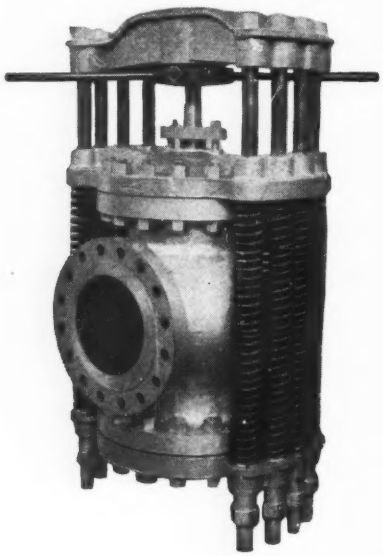

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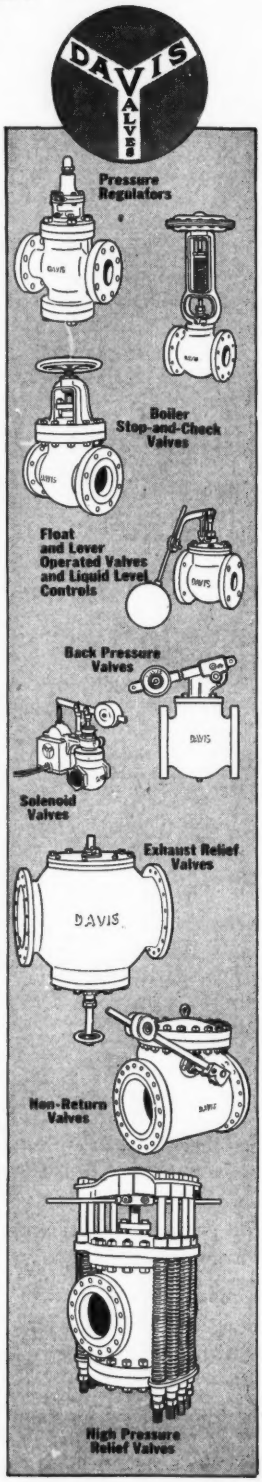

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the air, which is almost always present in minute quantities, and concentrates in the liquid oxygen in the reboiler of the fractionating column.

In the Elliott system, because of starting off at a lower pressure, acetylene is actually frozen out on the clean-up heat exchanger surface in exactly the same manner as the carbon dioxide and water vapor. The air leaving the clean-up heat exchanger is saturated with acetylene under the conditions of temperature and pressure. This quantity is considerably less than the quantity which the gaseous oxygen product can always remove continuously from the system, because a dangerous concentration cannot build up in the liquid oxygen in the reboiler. As a further safeguard, the accumulator (1)) is filled with silica gel to absorb acetylene at low temperature. The accumulator is of such size that it will adequately take care of the acetylene that will reach that point for at least six months without attention. The accumulator is installed with a bypass system so that every six months, without otherwise disturbing the operation of the plant, it may be removed from service and purged with warm dry effluent nitrogen.

MANOMETERS

(Continued from page 108)

nometer can easily be built. The fluids must be insoluble and have a specific gravity slightly less than the fluid flowing. Figure 6 shows a typical dual fluid enlarging type manometer. Equating static pressures and collecting terms,

$$px—py = h(W_{1m}—W_{m2}) \quad (8)$$

Also,

$$Hx—Hy = h\left(\frac{S_{m1}—S_{m3}}{S_f}\right) \quad (8a)$$

The densities and specific gravities of these fluids should be related as follows:

$$W_f > W_{m1} > W_{m2} \quad (9)$$

$$S_f > S_{m1} > S_{m2} \quad (9a)$$

To operate the manometer the flow rate through the pipe is adjusted until it is constant and then the level in jar *A* is adjusted until point *O* and *p* are on the same horizontal line. Then the reading *h* is taken and the pressure differential computed.

Practical Considerations

In addition to a familiarity with basic manometer types, a knowledge of the practical considerations which govern their operation is necessary for the successful use of manometers. These considerations will be discussed from the point of view of the open and differential types of manometers.

Tubes for the open type manometer should be of sufficient diameter to prevent capillary action,

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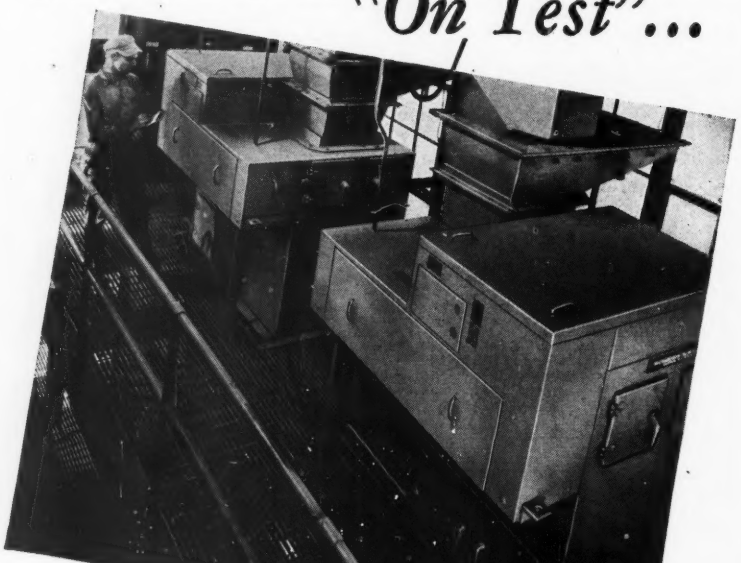

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particularly when small pressures are to be measured. Capillary action is undesirable because it will cause the value of h to be greater or less than the actual value, according to whether water or mercury is used in the tube. In general, tubes which are to be used with water should be at least ½ in. in diameter. Accurate work at low heads requires that the tube be at least 1 in. in diameter. Open manometers are not suitable for the measurement of rapidly increasing and decreasing pressures the change of liquid level is not as rapid as the change in pressure. Hence another type of pressure measuring device should be substituted for the open manometer when rapid pressure changes are encountered.

Open manometer tubes had best enter the pipe in a direction perpendicular to the direction of fluid flow. The inner surface of tube and pipe should be flush. Projection of the tube beyond the pipe wall will cause a disturbance which will result in an incorrect pressure reading. To prevent the accumulation of air in the tube, tap it into the side or bottom of the pipe instead of the top.

Capillary action does not alter the reading of a differential manometer because both menisci of the manometer fluid are similarly affected. Before using the differential type all air should be expelled from the tubes. If this is not done the readings obtained will be meaningless. The manometer fluid must not contain a volatile constituent because evaporation and a resultant change in density might occur. Finally, when using dual fluids they should always be checked to see that they are insoluble.

Thus it can be seen that the operation of the major types of manometers used in power plants is simple provided the tubes are of sufficient diameter, correctly tapped into the pipe, and well purged before using. Manometer calculations are also simple when consistent units are used at all times and the system is analyzed as shown in this article.

DEPRECIATION

(Continued from page 112)

sequently, it is customary to use an average life for the proposed new machine of less than what it is likely to serve if purchased. The depreciation rate, once the plan has been developed, should be set on a safe life, but perhaps greater than that used in the economy studies.

The type of analysis shown favors the existing machine, insofar as its equivalent depreciation charge is only the difference in between 1) what it is worth today as scrap, or as a secondary machine to another company, and 2) its probable value a year or so hence for the same

purpose. The wisdom of this is that the existing machine is on the job and requires no further expenditures other than for its current operation supplies and labor. The new machine requires an additional capital investment equal to its purchase price plus installation costs, and then, most likely, higher annual depreciation charges. In view of the present high price of goods in this post-war period, there is likely to be, for the next few years, distinct financial advantage in holding on to old production equipment. Certainly, the company that was fortunate enough to have built a modern plant about 1941 has a competitive advantage over a company that must build a similar new plant at 1948 prices.

Public Utilities and Private Plants

In both economy studies and cost accounting, public utility power plants can rightly use lower rates of depreciation than the managements of industrial power plants. This is because utilities have a more certain future. Various factors give them greater assurance that they will be given opportunity to obtain more nearly the full natural physical life from their property. The character of their load is more certain and not beset with so many probabilities of being radically altered. While the business of utilities is affected by the economic cycles, it is less so than is that of private business, which always must face uncertain competition as well as economic cycles. The risks are greater in private business; this in turn calls for a more rapid recovery of invested capital through higher depreciation rates.

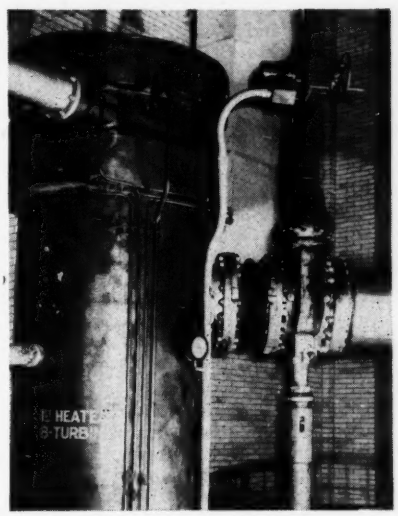
A study of several financial statements will disclose that, in general, utilities carry depreciation reserve account balances of much less percentage of their investment in depreciable property than do industrial corporations. Railroads carry the lowest reserves, mainly because only equipment was on a mandatory depreciation basis until their roadway properties were placed on the same basis January 1, 1943. Roadbed remains on a retirement accounting basis.

A second reason for using rather high depreciation rates in private industry is that the capital must be protected from unearned profit. Stated profits must be real profits; one assurance that they will be real is to make certain that depreciation charges are sufficient to return the cost of the property within its economic life and that losses need not be taken because of unforeseen obsolescence or retirement of the property for other reasons before it has been fully depreciated on the books.

Practical Results to be Desired

In the handling of depreciation as an element of cost it is not expected that the accounting will be in exact step with the decisions of the engineering and mechanical departments as to retirement of depreciable properties. All that can be hoped for is that the divergencies will be discovered early enough, so that the depreciation rates can be altered up or down, to maintain reasonable and safe annual charges and without excessive adjusting entries to surplus and reserves. Income tax regulations place the burden of determining depreciation charges on the taxpayer. At the same time these regulations discourage excessive charges, they stipulate that the company cannot recover excessive tax payments resulting from its own failure to make the proper charge for depreciation.

It is only by continued examination of the depreciable property of a company, watchfulness to catch early all technological developments which might result in excessive obsolescence of its equipment, and careful planning of new developments, that the charges for depreciation can be reasonably certain to be the best that current situations will allow. That they may, in the future, be proved to have been wrong, in no way lessens their correctness at the time they were made, provided that all factors than applicable were given just consideration in passing that judgment.



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Made of a special rubber compound to assure a gasketing material that combines exceptional strength and durability with *long-life* resilience and pliability. Will not creep, squeeze or blow out under normal temperature conditions. Designed for saturated steam up to 125 lbs. pressure; hot or cold water, and air. Available in 1/32" to 1/4" thickness, in rolls 36" wide.

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STYLE A-400. Another packing of *long-life* quality for steam, gas and oil pistons. Withstand pressures up to 300 lbs. and temperatures to 425° F. Tough, durable, resilient. Graphite lubricated. Also available in coil or ring types.

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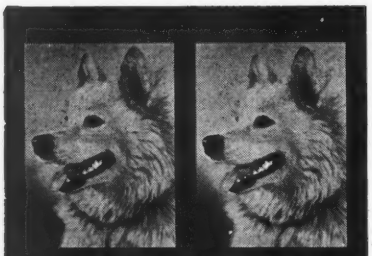

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These Huskies look alike, yet hidden differences make one the born leader. In water too, looks are deceiving. To meet this condition . . . to give boiler users one water treatment that is effective against all impurities in any water regardless of composition . . . K.A.T. was developed.

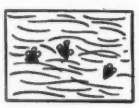
ALL COLLOIDAL K.A.T.* WATER TREATMENT

Functions by physical action—not chemical reaction

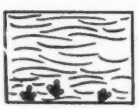
Employed as a complete or "finishing" treatment, user records show that K.A.T. improves boiler efficiency • Removes and prevents scale accumulation • Inhibits corrosion • Safeguards steam purity • Lowers fuel, labor maintenance costs • Permits almost continuous boiler operation.

K.A.T.

FIRST STAGE



SECOND STAGE



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It will pay you to test K.A.T. in your own plant today.

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CODE FOR PRESSURE PIPING TO BE REVISED

AMERICAN STANDARD CODE for Pressure Piping, safety standard for all steam and power services, is to be completely revised within the next two years, according to Frank S. G. Williams, new chairman of the committee which functions under ASME sponsorship and general manager, Eastern Division, Taylor Forge & Pipe Works.

Originally organized in 1926, the committee includes representatives of groups primarily concerned with safety of high-pressure piping systems. Members-at-large are recognized experts in the piping field. Sabin Crocker, Consulting Engineer of Ebasco Services, Inc., is vice-chairman, and L. W. Benoit of the Manufacturers Standardization Society of the Valve and Fittings Industry is secretary.

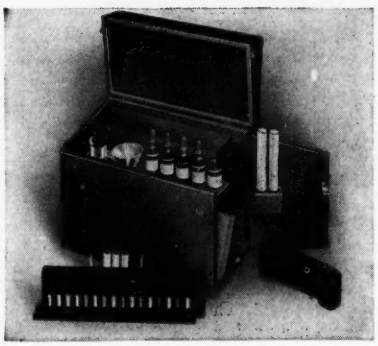
In his charge to the committee, Mr. Williams emphasized the character of the Code as a safety code rather than a design specification. He stressed the need for making periodic interpretations when necessity arises.

The present high repute enjoyed by the Code depends on the judicial character of the committee as a court of review. The large membership of the committee represents every reasonable cross section of public interest.

Committee operations will be directed, he explained, by an executive committee composed of chairmen of subcommittees, plus three to five members-at-large. This group would establish policies, supervise and coordinate, arrange publication and distribution of the Code, administrate the subcommittee work and maintain liaison with other code-making bodies.

Specific subcommittees were appointed to revise sections of the Code (1) power piping systems, (2) gas and air piping systems, (3) oil piping systems, (4) district-heating piping systems, (5) refrigeration piping systems, (6) fabrication, and (7) corrosion-service piping. A second group of subcommittees include (1) materials and stresses, (2) standards and identification, (3) instrument piping, (4) mechanical design, (5) liaison with ASME Boiler Code Committee, and (6) welding procedures and qualification.

Thus the chairman announced, technical subjects which cross all fields of service, such as instrument piping and mechanical design, will be handled by separate technical committees. It is proposed to recognize liaison with other code-making bodies as a major function and responsibility to eliminate overlapping of jurisdiction and achieve uniformity. For example, the committee will continue to look to American Society for Testing Materials for solutions to materials problems. A special



BOILER WATER COMPARATORS

Model P contains either High *or* Low Phosphate Comparator. Model W contains, in addition, 3 pH slides (pH 7.2-8.8); (pH 8.6-10.2); (pH 10-11.6) and accessories.

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Essential Tool in controlling Boiler Corrosion and Scale

Taylor Boiler Water Comparators help you control corrosion and scale by giving you fast, accurate checks on pH and phosphates.

Anyone can operate the easy-to-use Taylor Comparator, and make determinations of pH and phosphates in one to two minutes. Accuracy is assured by the unlimited guarantee against fading placed on all Taylor Liquid Color Standards. Nine standards, a complete set for each determination, are permanently enclosed in one plastic slide, eliminating the need for handling fragile, single standards.

The entire set comes in a convenient carrying case.

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Write today for your free copy of "Modern pH and Chlorine Control." Gives theory and application of control of process in 34 basic industries . . . useful to all men concerned with boiler maintenance. Also illustrates and describes Taylor Sets. See your dealer for Taylor equipment.

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committee on welding will keep its attention focused on developments in that field that affect the code.

The ASME Boiler Code Committee already has formed subcommittees to establish allowable stresses for materials. It is proposed to cooperate with this group rather than duplicate the activity.

An editing committee is charged with responsibility for uniformity of style and an indexing system for subject matter in each section of the code under uniform numerical references. This subcommittee also reviews incoming questions dealing with interpretation, makes a canvass of opinion among other subcommittees and recommends action to the executive committee. Interpretations of the code.

The field of "corrosion-service" piping is new to the committee. It includes stainless steel, nickel, Inco alloys, aluminum and copper. These materials, their use and methods of fabrication differ from steel to an extent that separate handling is justified. The chairman also suggested special study of the problems of operation at very low temperatures, below -20 F, not now a part of the code.

The executive committee will meet at six-week intervals until the work is well under way. Address all communications to the Secretary, L. W. Benoit, Manufacturers Standardization Society, 420 Lexington Avenue, New York 17, N. Y.

G.E. EDUCATION FUND

APPLICATIONS are now being accepted for research grants under the $1.000.000 General Electric Education Fund for the scholastic year of 1949-1950, it was announced recently.

For the 25th consecutive year, aid in grants up to $1,500 annually will be awarded to college graduates who wish to continue individual study and research in scientific and industrial fields.

The G-E Education Fund was established in 1945 honoring two former G-E presidents, Charles A. Coffin and Gerard Swope.

The Charles A. Coffin Foundation, honoring the company's founder and first president, and the Gerard Swope Foundation, named for General Electric's third president, annually provide more than $15,000 for research fellowships. Since 1923, when the first Coffin Fellowship was granted, some 194 fellowships totalling nearly $150,000 have been awarded to 161 persons.

Applications for the fellowships, which must be filed by January 1, 1949, have been distributed to libraries of engineering schools, department heads of electrical and mechanical engineering schools, professors of electrical and mechanical engineering, physics, chemistry, and metallurgy, and deans of graduate

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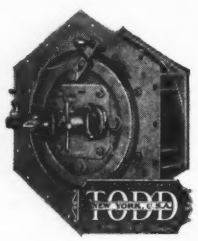

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schools. Applications must be mailed to the Secretary, General Electric Co., Education Fund, Schenectady, N. Y.

The Charles A. Coffin Fellowships are awarded in the fields of electricity, physics, and physical chemistry, with particular attention given the research problems of each applicant. Some 175 persons have been awarded the Coffin Fellowship since 1923.

The Gerard Swope Fellowships, founded in 1946, are awarded in the fields of industrial management, engineering, the physical sciences and any other scientific or industrial field. Some 19 persons have been awarded the Swope Fellowship.

Individual fellowships up to $1,500 annually may be granted with a grant of $500 available for specific apparatus or other expense in connection with the research. The grant for apparatus may be requested after the awarding of the fellowship. In addition, loans up to $1,000 may be also made.

Fellowships are intended for graduates who need financial assistance, and who have shown by the character of their work that they could with advantage undertake or continue research in this country or abroad. They are not intended for graduates who now hold, or expect to hold, any other fellowship which carries a stipend larger than the tuition of the institution where the research work is to be done.

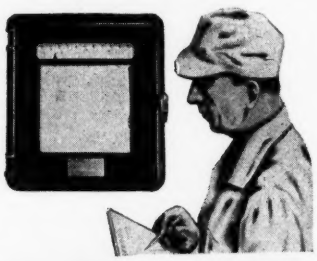
CHANGES IN CONSOLIDATED EDISON'S ENGINEERING STAFF

Consolidated Edison Co. of New York, Inc., has announced a number of organization changes in its Mechanical Engineering, Electrical Engineering and System Operation Departments. Gorden R. Milne has been appointed mechanical engineer, to succeed Edwin B. Ricketts, who retired on September 1. J. Elmer Goodale, formerly assistant electrical engineer, has been appointed to Mr. Milne's former post of manager, System Operation Department.

In the Electrical Engineering Department, J. Eliot McCormack, outside plant engineer, has been promoted to the new post of staff engineer, department office. Taking over Mr. McCormack's former duties is Walter B. Fisk, Jr., who was assistant outside plant engineer. Thomas C. Duncan, division engineer succeeds Mr. Fisk. Thomas Maxwell now "graduates" from the Consolidated Edison's Executive Development Program and has been named assistant distribution engineer.

In the Mechanical Engineering Department, William E. Caldwell, formerly in charge of the Mechanical Plant Engineering Bureau, has been promoted to the new post of staff engineer, department office. Harry Knecht, formerly assistant mechanical plant engineer, succeeds

RECORDS O_2



IN FEED WATER
and H_2 IN STEAM

The continuous records of the oxygen dissolved in boiler feed water and of the hydrogen entrained in the steam, point to the corrective measures necessary to prevent otherwise unsuspected and costly corrosion. The Cambridge Analyzers measure and record the dissolved oxygen directly. The hydrogen in the steam is the measure of the oxygen set free by dissociation. Cambridge Instruments are available for recording O_2 and H_2, either separately or simultaneously.

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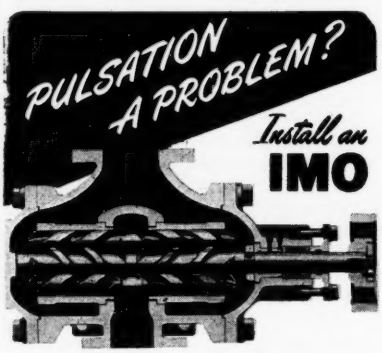
PULSATION A PROBLEM?
Install an IMO



With an IMO Pump delivery is not interrupted by the periodic strokes of a piston or the opening and closing of valves and ports. The turning of the rotors in an IMO forces the fluid from suction to discharge in a continuous, uniform flow.

IMO pumps can be furnished for practically any capacity and pressure required for oil, hydraulic-control fluids, other liquids.

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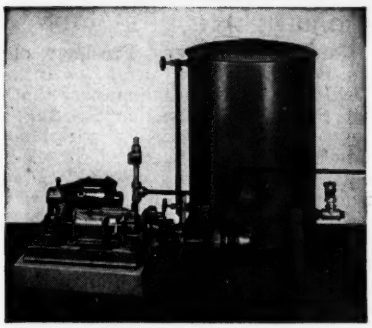
MILTON Roy CHEMICAL PUMPS



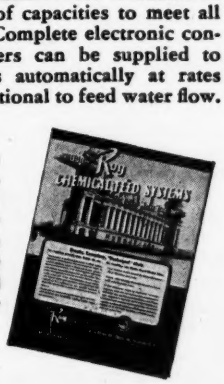
Complete Feed Systems for Boiler Water Chemical Treatment

Milton Roy "Packaged" Units for chemically treating boiler water are available to feed sodium sulfite into the suction side of the feed water pump and to feed other chemicals, such as phosphates, soda ash and caustic directly into each boiler. Both methods are usually recommended for the correct treatment of boiler water.

- TO REMOVE DISSOLVED OXYGEN, INSURE AGAINST CORROSION AND PREVENT PITTING.
- TO PREVENT SCALE FORMATIONS, CONTROL ALKALINITY AND PREVENT EMBRITTLEMENT.

Units are complete with Milton Roy Pumps, tanks, gages, low-level pump cutouts and alarms . . . are available in a wide range of capacities to meet all requirements. Complete electronic controls and meters can be supplied to operate pumps automatically at rates directly proportional to feed water flow.

Write for Bulletin 451 also Technical Paper 51 "What the Power Engineer Needs to Know About Chemical Feed Systems for Water Treatment."



MILTON Roy COMPANY

Mr. Caldwell. Taking over Mr. Knecht's former duties is Harry W. Dierman, formerly division engineer.

Two new bureaus have been organized in Mechanical Engineering: the Project Engineering Bureau, headed by James E. Whallon, formerly general superintendent of Mechanical Construction Bureau, Station Construction and Shops, and the Resident Mechanical Engnieering Bureau in charge of Edward H. Man, formerly special field engineer of the Process Department.

G. R. Milne

Mr. Milne has filled a variety of posts in the Consolidated Edison System. He was graduated in 1919 from Stevens Institute of Technology with a degree in mechanical engineering. He joined the United Electric Light and Power Co. as an engineering assistant in 1921. Following several promotions, he was named plant engineer for both the New York Edison and United companies in 1932. After the 1936 merger, he served as outside plant engineer and then as inside plant engineer for Consolidated Edison.

Five years ago he was assigned to Consolidated Edison's Executive Development Program. He worked as assistant purchasing agent; was in charge of station operation for the New York Steam Corp.; then became superintendent of East River electric generating station. He was named manager of the System Operation Department in January of last year.

J. E. Goodale

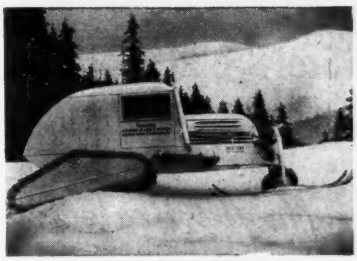
Mr. Goodale joined the Consolidated Edison System in 1919 as an engineering assistant with the New York and Queens Electric Light and Power Co. He came from Brooklyn Polytechnic Institute where he had just been graduated with a degree in electrical engineering. Winning rapid promotion, Mr. Goodale was named electrical designing engineer four years later and, in 1930, was appointed electrical engineer for the Queens company.

Following the 1936 merger of the companies, he was transferred to Consolidated Edison as manager of the Substation Operation Department. He held this post until 1940 when he was promoted to the position of assistant electrical engineer.

W. E. Caldwell

As the new staff engineer of Mechanical Engineering, Mr. Caldwell will make basic engineering and economic studies and assist the mechanical engineer in a general capacity. Mr. Caldwell, who was graduated in mechanical engineering from Drexel Institute in 1913, the same year joined the United Electric Light and Power Co. as a chemist at the Sherman Creek electric generating station, subsequently becoming test engineer. He was named assistant to the superintendent of power plants

NO SNOW TOO DEEP-- NO ROAD TOO STEEP!



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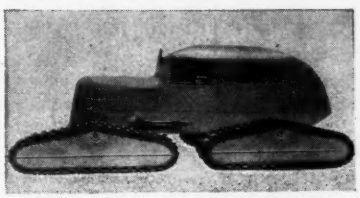
THE TUCKER SNO-CAT

Will Meet Your Most Difficult Snow Travel Needs . . .

- Over deep covered roads
- On steep side slopes
- Through wooded areas
- Through deep fresh snows
- and up steep grades



Model No. 643 Double Drive Freighter 10 Passenger 3-Door Sedan 140 h.p.

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". . . of course there may be a few places that the "Sno-Cat" can't go, but we have yet to find them. It will travel over fresh snow 30" deep and over hard crusted snow so hard that you cannot see the marks left by the tracks . . . The "Cat" acted very well, sinking into the snow less than a man on snowshoes would."

By E. R. Barber,
Southern California Edison Co.
Big Creek, California

". . . I have investigated most every kind of over-snow automotive equipment in the past twenty years and at last have found in the Tucker Sno-Cat an operation that is efficient and economical and is such an improvement over other types of over-snow equipment that there is no comparison".

By W. P. Rogers, Gen. Mgr.
Sun Valley, Idaho
(Owned by Union Pacific Railroad Co.)

Seven 1949 Models from Sports Roadsters to 4-pontoon-drive freighters

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Tucker Sno-Cat Corpn.,
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Please send me your descriptive folder on full line of Tucker Sno-Cats.

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Scale and Corrosion in Power Plant Equipment

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Newly Perfected

Water Conditioning Chemicals

Recently developed applications of the newer colloids and surface-active agents in Wright Chemicals for power plants result in *improved* water conditioning — *positive* scale and corrosion control. Wright Chemicals contain 100% soluble, available chemicals—no waste or inert matter—insuring increased operating efficiency and reduced cost.

Boiler Water . . .

Corrosion and scale-forming compounds in boiler water can be controlled with Wright Chemicals.

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Steam and condensate lines can be properly protected by using Wright recommended formulas.

Cooling Jackets . . .

Efficiency of cooling jackets can be substantially increased by preventing corrosion and scale deposits on heat transfer surfaces.

Wright improved chemicals are the result of intensive study and research by men with years of experience in the development, production, application and control of water-conditioning chemicals.

Wright has no one cure-all to solve all problems. Each receives individual treatment. The Wright field engineer, who will call on you upon request, will obtain all necessary information and samples for examination in the modern Wright laboratory. Analyses are interpreted in view of supplemental information received, and recommendations made in the form of a proposal. Clients are provided with regular laboratory service as a periodic check upon conditions.

There is a Wright Field Engineer near you, anxious to help solve your scale and corrosion problems. No obligation.

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in 1921 and later became research engineer.

In 1933 he was appointed chief efficiency engineer for both the United and New York Edison companies. Four years later he became engineer, Mechanical Engineering Department. Following the 1936 merger, he was placed in charge of the Consolidated Edison Mechanical Plant Engineering Bureau.

In 1933 Mr. Caldwell received the Melville Medal, which is awarded annually by the ASME, for an original paper on "Characteristics of Large Hell Gate Direct-Fired Boiler Units." He is the chairman of the Steam Turbine Test Code Committee of the ASME and author of articles on steam turbines and boilers that have appeared in trade journals.

Harry Knecht was employed by the T. E. Murray Co., in 1923, five years later joining the United Electric Light and Power Co., as an assistant engineer in Fixed Capital Records. Four years later he went to New York Edison Mechanical Engineering and later became a division engineer. He was named assistant mechanical plant engineer in 1946. He is a member of the Pump Test Code Committee, ASME, and author of several articles on steam turbine installations which have appeared in trade journals.

Both Mr. Caldwell and Mr. Knecht have contributed authoritative articles to POWER PLANT ENGINEERING, now POWER GENERATION.

JEAN SANTSCHI RESIGNS AT NORDBERG; STROMBERG SUCCEEDS HIM

ANNOUNCEMENT that Jean Santschi has elected, under a company retirement plan, to resign his position as Manager of the Installation and Service Department was recently made by Nordberg Manufacturing Co. While Santschi's retirement was effective September 30, 1948, he will continue to spend a considerable part of his time with Nordberg in Milwaukee and in the field in a consulting capacity.

Mr. Santschi was born in Switzerland on September 1, 1883, and got his first engineering training in that country. In 1904 he went to Belgium and found employment at the Usines Carels Freres at Ghent, in their Experimental and Testing Department, which was under the supervision of Dr. Rudolph Diesel. In 1914, Carels Freres sent Santschi to the United States to install two 1250-hp Diesel engines in a Phelps Dodge plant in New Mexico. When he completed the installation work on the two Carels engines in the Spring of 1915, it was impossible for him, because of the war in Europe, to return to Belgium and Dr. Bruno V. Nordberg prevailed upon him to join Nordberg as Test Engineer for Diesel engines.

In 1925, Santschi was appointed Manager of Installation and Service of Marine and Stationary Diesel engines and other machinery built by Nordberg, the position he held at the time of his retirement. Matt Stromberg, who has been Santschi's assistant for many years, has been appointed to succeed him.

PENNSYLVANIA CRUSHER CO. BROADENS LINE

JOHN R. KUENEMAN, President of the Straub Manufacturing Co., Inc., Oakland, California, announces that the Pennsylvania Crusher Co., Liberty Trust Building, Philadelphia, Pennsylvania, has acquired the exclusive manufacturing and sales rights in eastern United States and Canada.

The operating mechanism of the Kue-Ken has been simplified, encased, and sealed against dust. An oil reservoir and pump provide a constant oil bath to all moving parts.

These enable the crushers to produce a uniform product with a negligible percentage of fines, and make possible substantial reductions in per ton operating and maintenance costs. The crushers are adapted for handling highly abrasive materials. Additional results include horsepower savings of approximately 40 per cent; longer wear of jaw plates due to minimization of rubbing; protection of bearings, shafting, toggles and other moving parts by proper oiling. The arrangement of toggle and pitman mechanism has resulted in a 90% reduction in weight of the pitman.

WORTHINGTON PUMPS BEING BUILT FOR NEW CINCINNATI PUMPING STATION

CINCINNATI awarded Worthington Pump and Machinery Corp. the contract for six electric-driven centrifugal pumps, with motors and controls, for the new Tennyson Avenue Pumping Station. This is part of Cincinnati's five-year multi-million dollar improvement program. The new pumps will make available to the city 150 million gallons of water per day, in addition to the present 165,000,000.

Two of the new pumps will be two-stage, powered by 3000 hp General Electric motors; each capable of delivering 25,000,000 gallons of water daily to the Eastern Hills system, at about 200 lb pressure. One two-stage pump, for Eastern Hill's variable speed service, will be rated at 20 million gallons per day. This unit will be driven by a General Electric 2500 hp variable speed motor.

Three single-stage pumps, rated at 25,000,000 gallons per day will be powered by General Electric motors, each of 1250 hp, and will supply 75,000,000 gallons of 75 lb pressure to the Central Service System.

The General Electric Co. will supply controls and accessory equipment for all the pumping units.

The City of Cincinnati and Worthington are coupled together with

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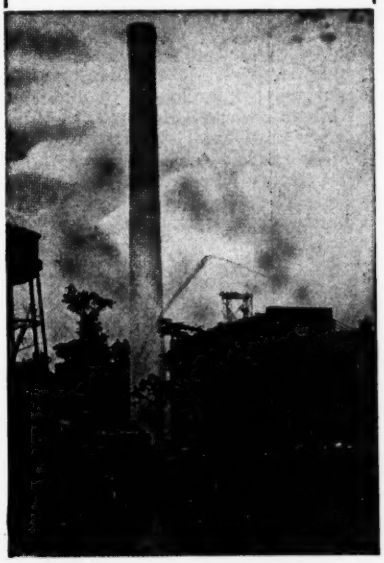

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historical interest in the city's growth. In 1886, the first vertical direct-acting water works engine ever built was installed by Worthington in the Cincinnati Municipal plant; and the city's present steam-driven system, begun in 1898, involved seven vertical triple expansion pumping engines, totaling 128,000,000 gallons per day, built by Worthington.

In 1934, a 25,000,000-gallon-per-day steam turbine driven, two-stage centrifugal pump was added to the Eastern Hills Main Station. Then, in 1940, four single-stage motor-driven 18-in. vertical pumps were placed into operation at the California Low Service Station, located on the Ohio River, several miles east of the city. These motor-driven units were for emergency service during flood periods.

At the present time, about 120,500,000 gallons of raw water are pumped from the river to the settling basins, thence through waterwheel generators to the filter plant. From the filter plant, the water flows through a 22,000 ft underground tunnel to the main pumping station.

A new underground tunnel, approximately 14,000 ft long, will be built to supply water to the new Tennyson Avenue Station.

SIEGER ELECTED PRESIDENT OF AWS

THE AMERICAN WELDING SOCIETY has elected George N. Sieger of Detroit as its president for the year 1948-49. Mr. Sieger was President of the S-M-S Corp., Detroit. He was installed at the annual meeting at Philadelphia during the week of October 24th.

Mr. Sieger is a past president of the Resistance Welder Manufacturers Association. During the war he served as chairman of the Task Committee, Resistance Welding Electrodes Advisory Committee and as a member of Task Committee, Resistance Welding Machines Advisory Committee of the War Production Board. He was also a consultant on cemented tungsten carbides for the Cutting Tools Section staff of the Board.

Mr. Sieger has held many offices in the Society, serving as its First Vice-President in 1947-48. He is a graduate of Lehigh University with a degree of Electro Metallurgist. Mr. Sieger is a member of the American Society for Metals and the Society of Automotive Engineers.

Appointment of Energy Control Co., Inc., 5 Beekman Street, N. Y., as general representatives for Lonergan products in the New York Metropolitan area (including Northern New Jersey), as well as in Southern Connecticut, and the Hudson Valley all the way to the Canadian border.

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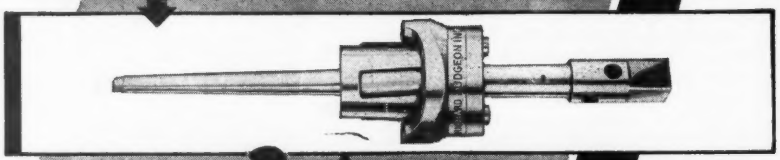

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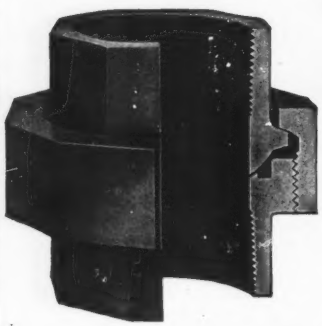
Herman B. Campbell, vice-president in charge of operations of Harbison-Walker Refractories Co., has retired after 44 years service with the company. Mr. Campbell became associated with Harbison-Walker in 1904 at the Portsmouth, Ohio, plant, and soon was appointed district superintendent of the Ohio and Kentucky districts. In 1910 his jurisdiction was expanded to include the Alabama works. He came to Pittsburgh in 1922 to join the works and mines department with which he served as department head, and since 1939, as operating vice-president.

C. E. Tweedle, Assistant to the President of the Askania Regulator Co., was elected Vice President of the company at the last meeting of the Board of Directors, Mr. H. J. Velten, President, announced recently. Mr. Tweedle first became associated with Askania in October, 1946. Prior to that time he served in the United States Navy as Commander and was Executive officer of the Administration command, Great Lakes Naval Training Center. A graduate of the Illinois Institute of Technology, Mr. Tweedle was engaged in consulting engineering work prior to the war.

Fisher Governor Co., Marshalltown, Iowa, has appointed Wickersham-Petty & Company, Park



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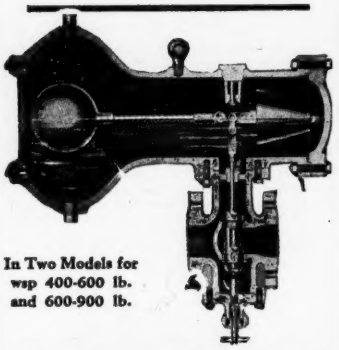

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The appointment of Edward X. Hallenberg as assistant director of the Westinghouse Research Laboratories has been announced by Dr. J. A. Hutcheson, director of the laboratories. Mr. Hallenberg, who was formerly personnel manager at the Laboratories, will serve as administrative aide to Dr. Hutcheson. In addition, he will assume responsibility for all laboratory service activities. He was graduated from the University of North Dakota in 1937 with a degree of Bachelor of Science in electrical engineering, and he joined Westinghouse the same year at the company's Sharon Transformer Division. Ultimately, Mr. Hallenberg was named assistant to manager of industrial relations. He joined the Westinghouse Research Laboratories as personnel manager in 1946.

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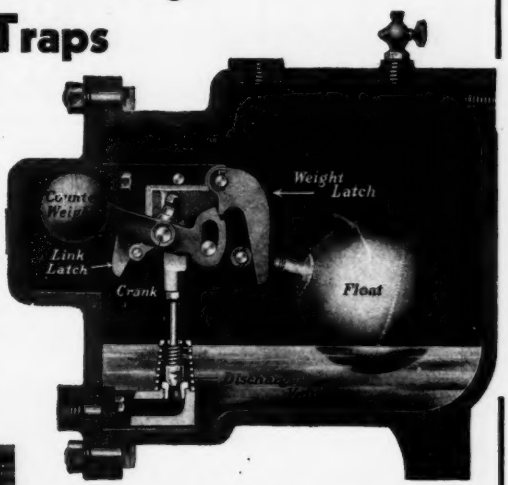

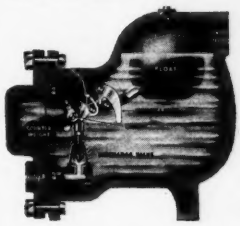

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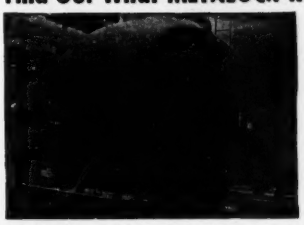

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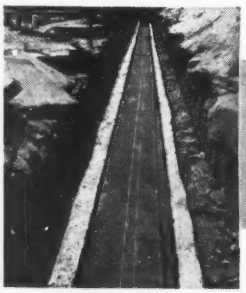

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POWER PLANT *Construction News*

Birmingham, Ala.—American Bakeries Co., 10 Pryor St., S.W., Atlanta, Ga., crackers, biscuits, etc., plans boiler plant at proposed new one-story bakery on Vanderbilt Rd., Birmingham, where site has been selected Traveling ovens and mechanical-handling facilities will be installed. Complete project will represent a reported investment of about $1,000,000.

Ajo, Ariz.—Phelps-Dodge Corp., 40 Wall St., New York, N. Y., plans power plant in connection with new copper smelting works at Ajo, comprising crushing plant, reverberatory furnace, converter and other units. Entire project is estimated to cost about $5,000,000. Work is scheduled to begin soon.

Marysville, Calif.—Pacific Gas & Electric Co., 245 Market St., San Francisco, Calif., plans extensions in Colgate hydroelectric generating station, near Marysville, with installation of additional hydraulic turbines and electric generators to provide about 35,000-hp capacity. Cost reported approximately $3,500,000. Work is scheduled to begin at early date.

Ukiah, Calif.—Masonite Corp., 111 W. Washington St., Chicago, Ill., wood fibre insulating board, wall board, etc., has approved plans for new branch mill at Ukiah, where large tract of land was secured several months ago. It will comprise a main one-story processing and production building, with facilities for large output. A boiler house will be built. Cost reported over $1,200,000, with machinery.

Devon, Conn.—Connecticut Light & Power Co., Hartford, Conn., has plans maturing for proposed new steam-electric generating station, initially projected a number of months ago, and will proceed with steel frame superstructure at early date. Award for structural steel framing has been let. Installation will include turbine-generator, high-pressure boiler and auxiliary equipment. No official estimate of cost announced. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is engineer and will supervise erection.

Winter Haven, Fla.—City Council plans extensions and improvements in municipal steam-electric generating station, including installation of additional equipment. Cost reported about $300,000. Plant was owned and operated previously by Tampa Electric Co., and recently purchased by municipality for a municipal project.

Newman, Ga. — Georgia Power Co., Atlanta, Ga., will double capacity of new steam-electric generating station now in course of construction near Newman, and station will be equipped for a rating of 200,000-kw, instead of 100,000-kw, as initially planned. Project will represent a large investment, including power substations and transmission lines.

Cedar Rapids, Iowa—Iowa Electric Light & Power Co. has plans for addition to local steam-electric generating station, for expansion in steam division, comprising a multi-story building, 64 x 96 ft. Cost about $285,000, exclusive of equipment. Work on superstructure will begin soon. Abell & Howe Co., 1026 Third Ave., S.E., Cedar Rapids, is engineer.

Ruston, La.—Town Council plans extensions and improvements in municipal oil engine-operated power plant, with installation of equipment for increased capacity. Bond issue of $425,000 has been authorized for project. Proposed to carry out work soon.

Worcester, Mass.—Worcester County Electric Co., 11 Foster St., plans addition to power plant, with installation of additional equipment. Cost about $350,000, exclusive of equipment. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is engineer and will supervise erection.

Jackson, Mich.—Consumers Power Co. is carrying out an expansion and improvement program in generating stations and other properties to represent a gross expenditure of $95,000,000 in 1948 and 1949, a considerable part of fund to be used in latter year. In addition to increased power plant capacity, work will include power substations, transmission and distributing lines, and other operating facilities.

Minneapolis, Minn.—Minneapolis Brewing Co., 1215 N.E. Marshall St., plans new boiler house in connection with an expansion and improvement program at brewery. Several additional buildings will be erected. Entire project will represent a reported investment of approximately $2,000,000. Work will be placed under way soon.

Union, N. J.—Purolater Products, Inc., 744 Broad St., Newark, N. J., oil filter equipment, is considering boiler house at proposed new plant on 25-acre tract of land at Liberty

Ave. and Spruce St., Union. It will comprise a main one-story building and several smaller structures. Entire project reported to cost close to $1,000,000, with machinery. Walter Kidde Constructors, Inc., 140 Cedar St., New York, N. Y., is architect and engineer.

Buffalo, N. Y.—Buffalo Niagara Electric Corp., Electric Bldg., has authorized fund of $59,400,000 for expansion and improvements in generating stations, power substations, transmission and distribution lines, and other operating facilities. Of this amount, approximately one-half, or $27,750,000 will be expended for new steam-electric generating plant at Dunkirk, N. Y., previously noted in these columns, on which work has begun. Station is scheduled for completion late in 1950.

Watertown, N. Y.—Central New York Power Corp., 300 Erie Blvd., W., Syracuse, N. Y., plans new hydroelectric generating station on Black River at Glen Park, near Watertown. Plant will be constructed by Black River Development Corp., a subsidiary interest, and operated by Central company. No estimate of cost announced but will represent large investment. Application has been made to Federal Power Commission for permission to proceed with project.

Grand Forks, N. D.—Summers Fertilizer Co., Stock Exchange Bldg., Baltimore, Md., commercial fertilizers, plans boiler house at new branch plant at Grand Forks, where site has been acquired. It will comprise a main one-story building for compounding and general manufacture. Work will begin early next spring. Cost reported approximately $100,000, with machinery.

Cleveland, Ohio—Cleveland Electric Illuminating Co. is arranging appropriation of about $40,000,000 for expansion and improvements in plants and system during 1949. Extensions will be made to generating stations to provide for a gross increase of 180,000-kw. Other work will include power substations, transmission and distribution lines, and miscellaneous operating facilities.

Duncan, Okla.—Town Council has plans under way for addition to oil engine-operated municipal power plant, including installation of new Diesel engine-generator unit and accessories. Surveys and estimates of cost are being made. V. V. Long Engineering Co., Colcord Bldg., Oklahoma City, Okla., is consulting engineer.

Hollidaysburg, Pa.—State Dept. of Property and Supplies, Herr and 18th Sts., Harrisburg, Pa., plans new power house at State Hospital at Hollidaysburg, for central steam-heating service. Cost estimated about $440,000, with boilers and auxiliary equipment. Also will make extensions in steam-distribution system, including tunnels, to cost approximately $133,000. A. F. Jones is chief engineer for department.

Camden, S. C.—E. I. duPont deNemours & Co., Inc., Rayon Division, duPont Bldg., Wilmington, Del., plans power plant at proposed new synthetic fibre mill near Camden, where large tract of land recently was acquired. It will consist of several multi-story buildings for processing and general production, with equipment installation for heavy output. No official estimate of cost announced but reported in excess of $7,000,000. Work is scheduled to begin next spring.

Greenwood, S. C.—Greenwood Mills, Inc., cotton and rayon products, plans boiler house at proposed new filament rayon mill on site at or near Greenwood, where present mill is located. It will comprise a main one-story processing and production building, equipped for large output. Cost estimated over $5,000,000. Completion is scheduled in about 18 mos.

Agua Dulce, Texas—Panhandle Producing & Refining Co., City National Bank Bldg., Houston, Texas, plans new compressor plant at Agua Dulce, for natural gas pipeline service, with compressors and auxiliary equipment for large capacity. Cost reported over $700,000. Work will be carried out at early date.

Winters, Texas—Town Council plans extensions and improvements in municipal gas engine-operated power plant, with installation of additional equipment. Bond issue of $150,000 has been voted for project and work is expected to begin at early date.

Richmond, Va.—Hinde & Dauch Paper Co., Inc., Petersburg Pike and Hopkins Rd., corrugated fibre boxes and containers, is considering boiler house at proposed new plant on Petersburg Pike. It will consist of a main one-story converting building, equipped for large capacity. No estimate of cost announced, but reported in excess of $200,000. Carneal & Johnson, Atlantic Life Bldg., Richmond, are architects. Main offices of company are at Sandusky, Ohio.

Holcombe, Wis.—Northern States Power Co., 15 S. Fifth St., Minneapolis, Minn., plans early construction of new hydroelectric generating station on Chippewa River, near Holcombe. Building will be 70 x 250 ft, and 40 ft high. Public Utility Engineering & Service Corp., 231 S. LaSalle St., Chicago, Ill., is consulting engineer.

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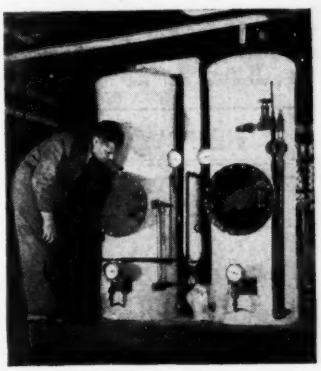

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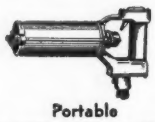

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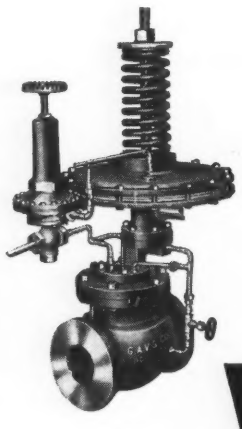

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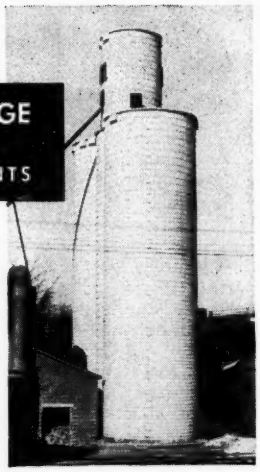

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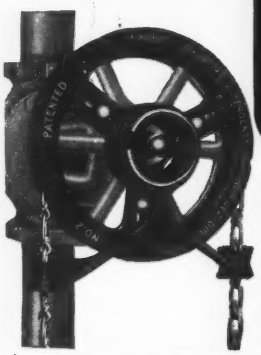

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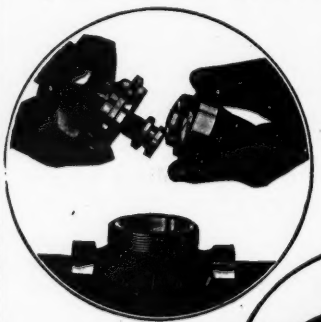

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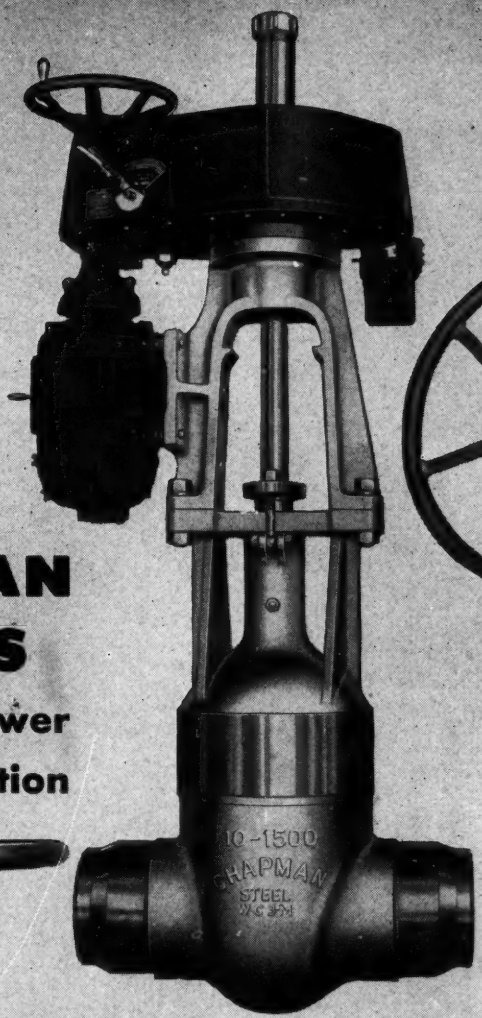
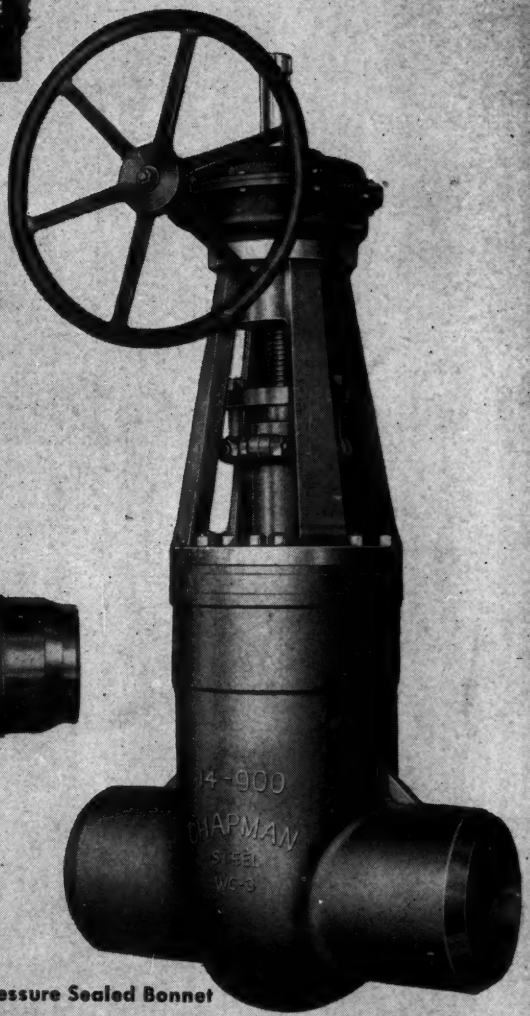
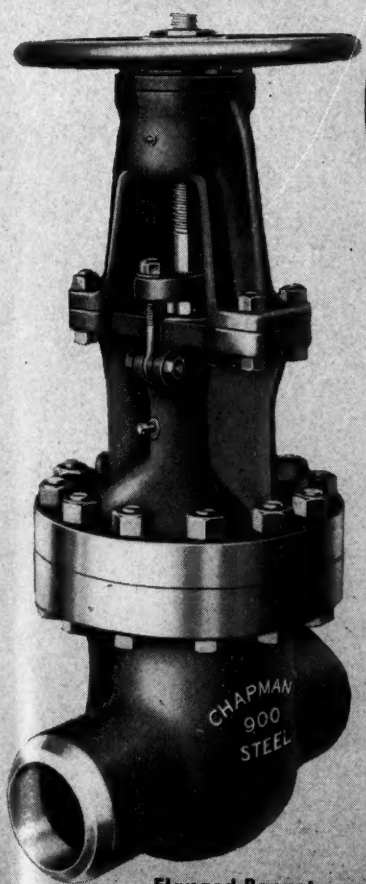


Welded Bonnet



Pressure Sealed Bonnet



Flanged Bonnet

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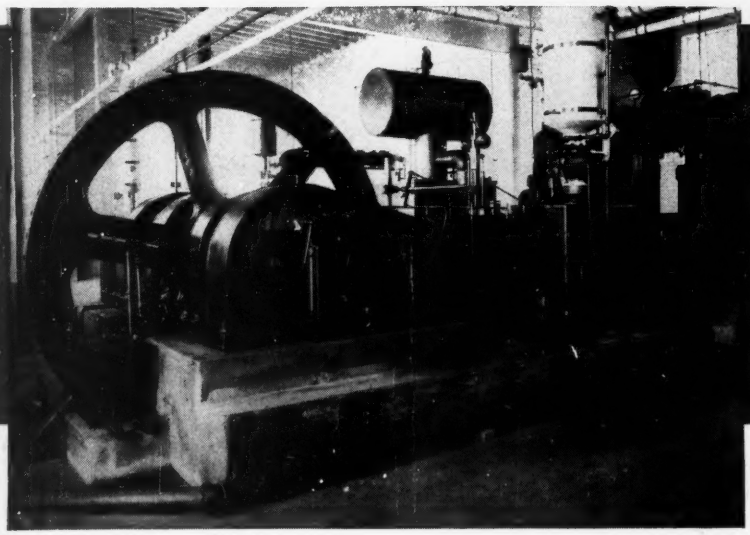

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